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From the Editor

by Doug Hendricks, KI6DS

You will have noticed that you received two issues of QRPp in one mailing. I had fallen so far behind, that it was necessary to do two issues and mail them at the same time. A few of you had your subs expire with the Summer issue, you got a bonus for being so patient. Thank you for your patience and understanding. For the first time since my bypass 3 years ago, I am caught up with things. Now to do some operating and enjoy the coming basketball season. Please check your mailing label or the NorCal web page at www.norcalqrp.com for the status of your subscription. If you have run out with either this or the summer issue, please renew by sending in your money to Jim. Thanks for your support and participation in QRP. Next Spring will mark the 10th anniversary of NorCal. Help celebrate by operating, building and being involved in QRP. 72, Doug

A Robust Rock-Mite Rendition

By
Jerry Henshaw
KR5L

Construction

I saw a picture of Doug Hendrick's Rock-Mite on Rod's (N0RC) web site and was inspired to build my version of the rig. I will be the first to admit that I have violated the spirit and letter of Dave Benson's goal of a simple one evening project that could easily fit into the proverbial Altoids tin. I decided to see how much electronics I could stuff into a nifty little enclosure I bought a Dayton several years ago. See Photos 1 and 2. The box is still available at Mendelson's Electronics (MECI part number 160-0181) for $4.95 plus shipping, etc. I like the removable metal side rails that can accept a PC board. I used

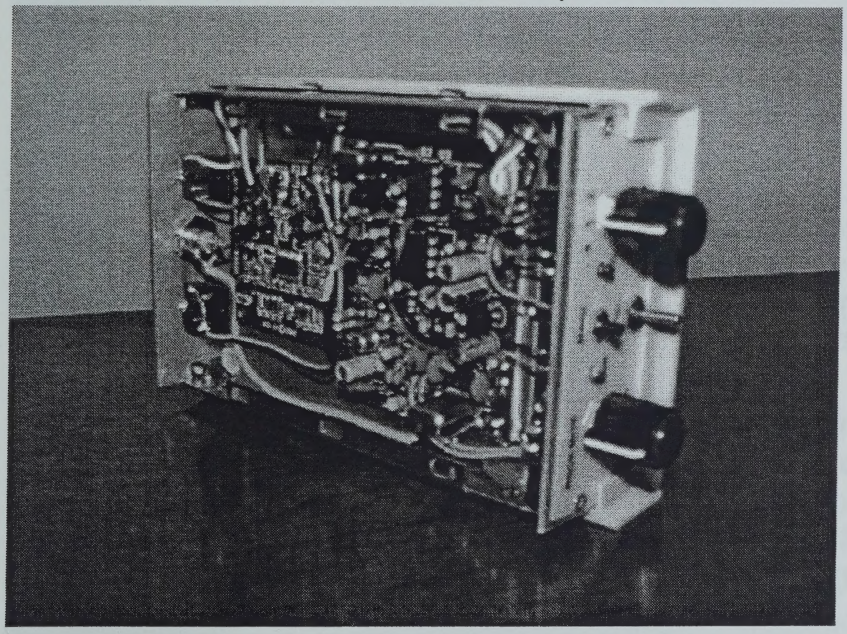


Photo 1

a two-story approach to housing all the goodies in this little enclosure. Below is an inventory of the modules contained in

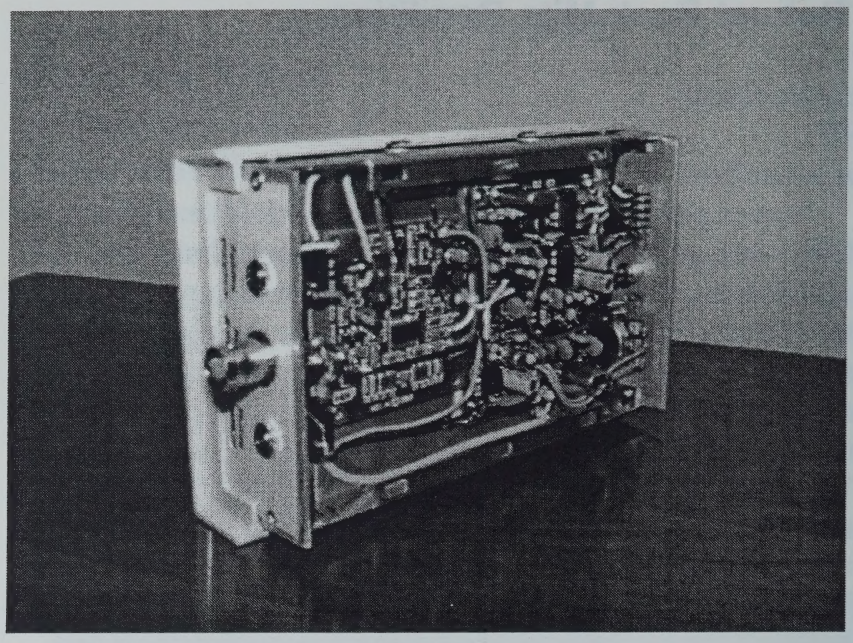


Photo 2

the box:

· Rock-Mite 40 meter transceiver
· Steve Weber's AAPB Audio Filter
· Embedded Research EPS-1 DC to DC converter (12 volts out)
· 4 AA Battery holder (6 volts input to the EPS-1)

The bottom "story" contains the batteries and EPS-1 converter. I cut a slot in the bottom of the enclosure to allow easy access to the 4 AA batteries. I used a discarded PC card slot blank for the metal strap to secure the battery holder (a 4-40 hex nut expoxied on the inside of the case holds everything together). See Photos 3 and 4 for a close-up of power supply configuration. I bought the EPS-1 DC to DC converter at Dayton several years ago when they first came out. I have been waiting for just the right project to put it to permanent use — the Rock-Mite was that project. The nifty thing about

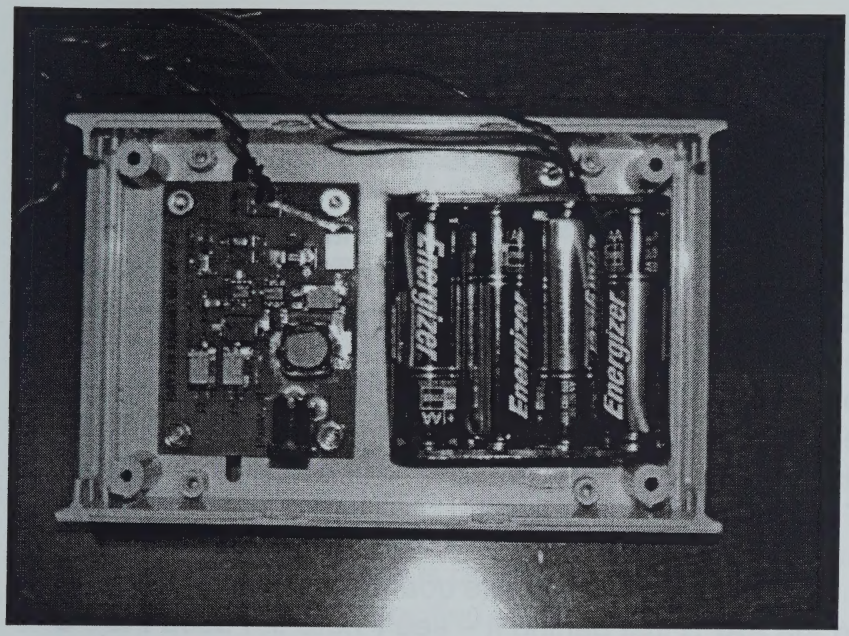


Photo 3

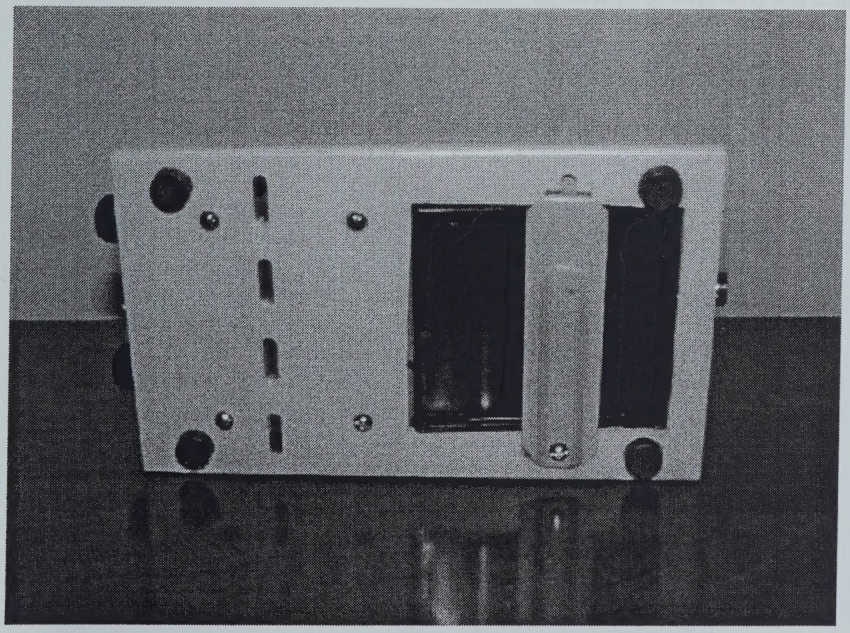


Photo 4

the EPS-1 is in can operate down to 2 volts input and still put out 12 volts. You can still get a lot of useful life out of weaker batteries by using the EPS-1. The current limit of the EPS-1 is about 500ma – more than adequate for the little Rock-Mite and AAPB filter unit.

I used a piece of PC board material out of my junk box (probably came from Radio Shack) as the foundation for the second story of the unit. The PC board slides into slots on the side rails of the enclosure. The PC board provides both a mounting surface as well as a ground plane and shield for the rig. I wanted to make sure the EPS-1 wouldn't generate noise in such tight quarters. The PC board provides a good RF shield as well. It works well, I can't detect any digital noise whatsoever in the rig.

I mounted the Rock-Mite board toward the front panel and the AAPB just behind it – see Photo 5. I used the PC board as the ground plane for both the AAPB and Rock-Mite

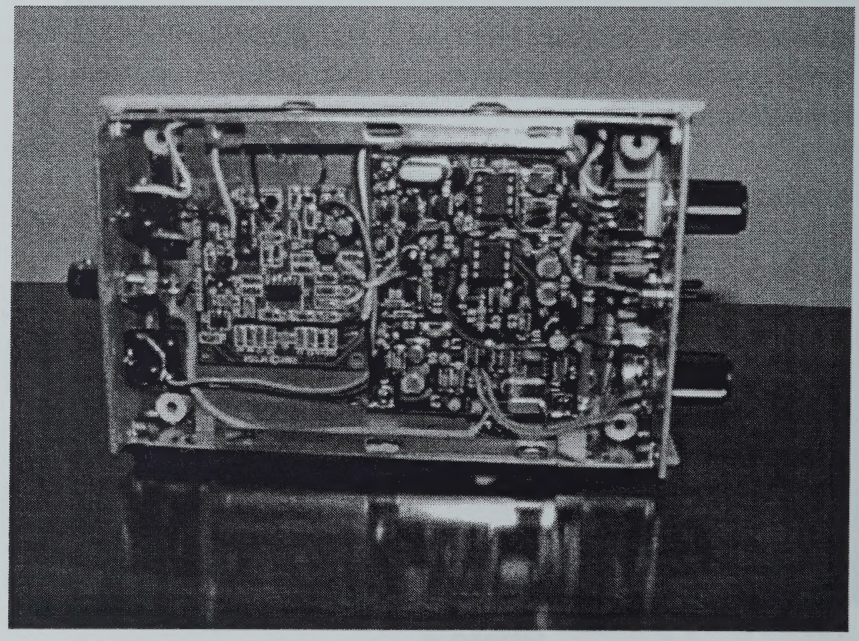


Photo 5

units. The large ground plane makes an effective low impedance ground return for the unit. This large ground plane gives some of the same benefits (low noise, etc) as Manhattan construction.

I made a couple of mods to the Rock-Mite board. I increased the value of R1 and R8 to 1K to reduce the zener bias current with a 12-volt power input. The original resistor values were chosen for 9 volt operation. I added a "Shift" LED to let me know when the frequency of the Rock-Mite was shifted. This mod required placing an LED in series with the zener D5. I reduced the value of D5 to 5.6V (originally 7.5V) and carefully measured the forward voltage drop of several of my junk box LEDs until I found one with a 1.8 volt drop. The series combination of my new D5 5.6 V and my "Shift" Led 1.8 V equals 7.4 Volts which is close enough to the original 7.5V that Dave Benson specified. Thus the amount of frequency shift is the same as the original design. I highly recommend the shift LED mod as it is difficult to know which of the two operating frequencies you are on without it. I made a custom heat sink for the final transistor out of a tin can – I cut a ¼ inch wide strip of tin, folded it in half, and wrapped it around a drill bit of the same diameter of the 2N2222 and formed a little heat sink.

I used my "Modified Doofus" SMD hold down jig with a "ticky-tack" glob on the end to hold the SMD parts in place while building the AAPB. The little jig worked great. I used two lead weights which proved to be just the right amount of holding power. A picture and description of this tool can be found on the NORCAL website under SMD Hold Down Jigs. I also used a toothpick with a little dab of "ticky-tack" to pick up and place the SMDs on the pc board. I find this method far superior to using tweezers that have a tendency to launch SMD parts into never-never land. Steve called for some black rubber sealer to enclose the ends of the heat shrink "light tube" that houses the green LED and photo resistor. I used

some black model airplane enamel that I had laying around the house to seal the ends – worked just fine and saved a trip to the store.

The front panel has the following: (See Photo 6)

· AF Gain (Volume)
· AF Filer Select
· Power
· Menu
· Shift LED
· ALC LED

The rear panel has the following: (See Photo 7)

· BNC RF Output
· Paddles
· Phones

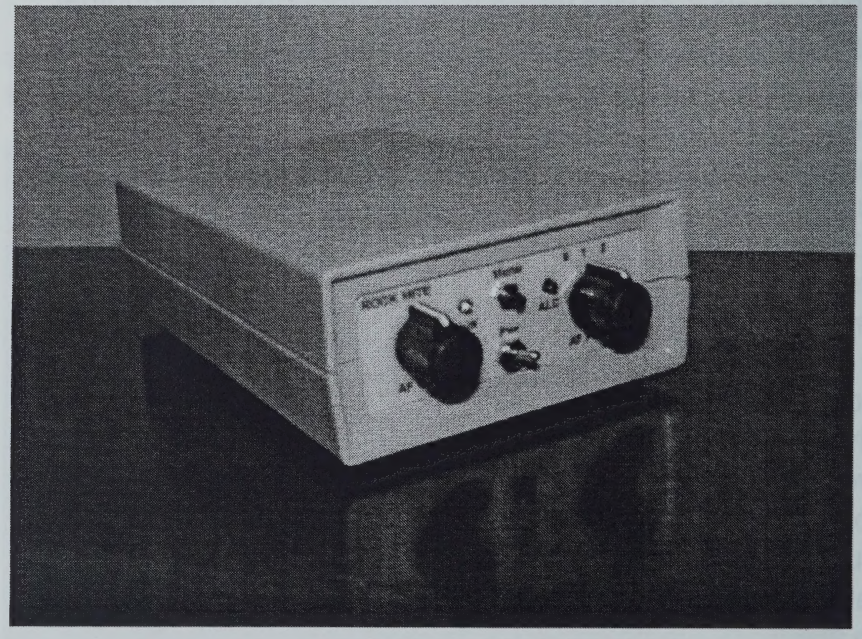


Photo 6

I had a problem finding a suitable volume control pot and three position rotary switch in my junk box or at Radio Shack. The space behind the front panel is really cramped. I

Photo 7

ordered a miniature 100K pot from Mouser (313-4000-100K) for $1.94. MECI had a 2 pole 3 position rotary switch in their catalog (540-6316) for $.95. These are miniature controls that fit the box perfectly. The audio taper pot from Mouser has 11 detent positions which give a good tactile feel to the volume control. The remaining panel mount parts came from Radio Shack or my junk box.

My word processor was used to generate the lettering for the front and rear panels. I used light gray card stock and my laser printer to make the panel overlays. I secured the overlays to the metal panels with clear packing tape. The tape provides a protective film for the printed overlays.

Operation

The objective of this project was to have a self-contained rig that requires only a resonant antenna, paddles, and headphones to get on the air. The rig meets the criteria.

The EPS-1 power converter works great in this appli-

cation. It generates no digital hash and provides a solid 12 volt output to the rig. My Rock-Mite puts out 500mw with the 12 volt supply voltage.

The AAPB filter is a MUST for this rig. Steve Weber really has a winner with this little filter. I used a 3 position rotary switch to select zero, one, or two filter stages. The filter provides a nearly constant audio output level and its action is indicated on the front panel ALC LED. This filter really cleans up the Rock-Mite square wave side tone. With the filter switched out of the audio chain, the sidetone sounds loud and rather harsh. With the filter in, the sidetone sounds clean and "smooth". I use the number 1 filter position most of the time and switch to number 2 when the QRM or noise is heavy. This filter removes the pops and strong signal ear splitting eruptions that we are all familiar with.

I really like the frequency shift LED. It serves as a power on indicator and gives you a visual indication of which operating frequency you are on. Without the indicator, you have to make a mental note of how many times you pushed the "Menu" button. I strongly suggest you add this mod to your Rock-Mite.

The Rock-Mite has a built-in keyer that is activated by pressing and holding the "Menu" button until a Morse S is heard. You increase the speed of the keyer hitting the "dit" side of your paddle and decrease the speed with the "dah" side – the defacto QRP standard method. Dave's keyer implementation allows the use of a straight key or external keyer by simply holding either the "dit" or "dah" side of the paddle during power up.

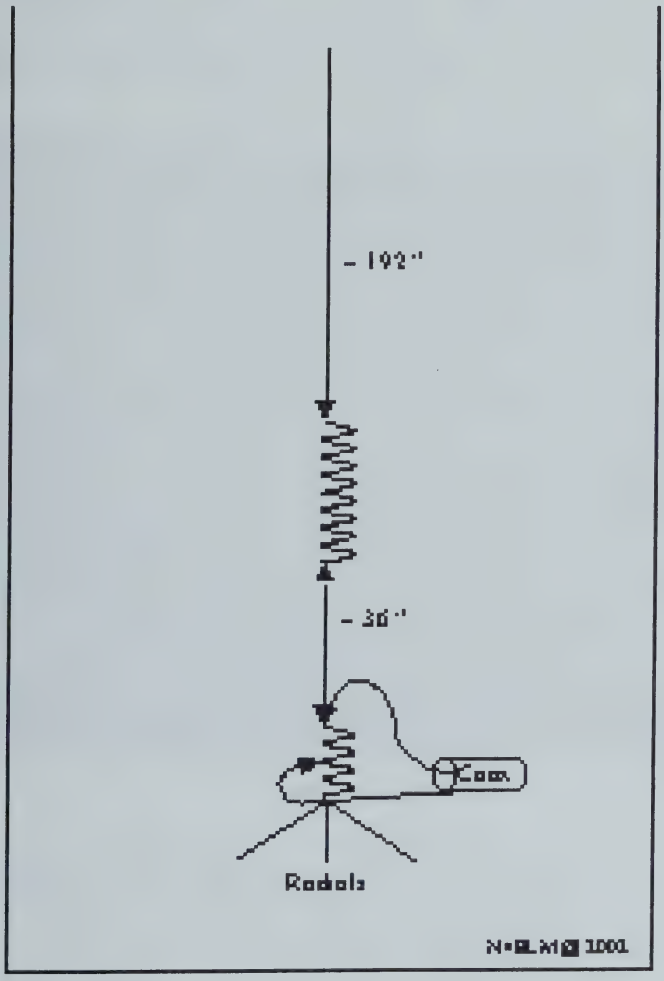
All in all, the Rock-Mite is a nifty little rig in and of itself. Dave's goal of a one-evening rig has been met in spades. The Rock-Mite is a huge improvement over its distant cousin the Norcal 49er (yes, I have one of those too!). I chose to take the Rock-Mite to the next level and I am very pleased with the results. If you are interested in finding out more information about the Rock-Mite, go to Rod Cerkoney's webpage

http:\\www.radioactivehams.com/~n0rc/rm/. Rod has compiled a complete list of links, pictures, mods, operating schedules, etc. on his awesome site – check it out.

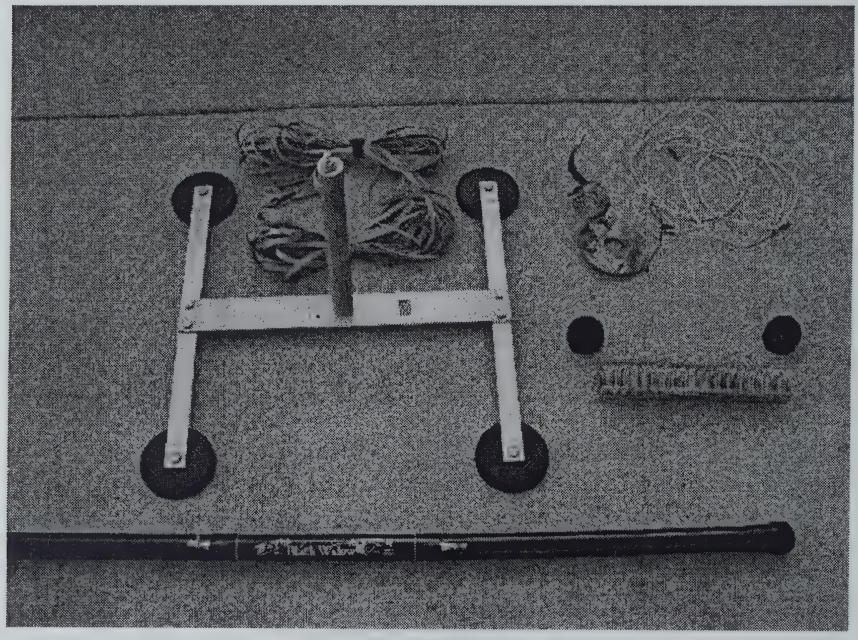
See you on the air on or about 7.040 MHz.

80 Meter Alligator
A Non-Rigorous Approach to Antenna Design

by Dave Redfern, N4ELM



A few days before leaving for Arkiecon at the Ft Smith Hamfest, I decided to put together a temporary antenna to hopefully allow me to check into a Friday evening CW roundtable net on 80 meters near Dallas, TX. Based on previous experience at the Guesthouse Inn at Ft. Smith, I thought I would have better results if I could mount something on the car in the parking lot. Looking around the garage, I located a SD-20 telescopic fishing pole, lots of wire, alligator clips, and some B&W coil stock. I remembered a variation on the ST. Louis Vertical that used a loading coil with a variable tap to tune several bands but I couldn't quickly find the QRPp article, so I just decided to do some quick calculations and see if what I had would come close to working.



Garage Treasure

Calculations

For quick antenna estimates, I use the older ARRL Antenna Book (1974) and the ARRL Electronics Data Book (1976) as quick references. In the Antenna Book, Fig. 10-2,

is a chart to estimate the inductance values for an off-center loaded dipole. For my antenna, being a 1/4 wave, I just needed to calculate one side. To use the table you need to know: A – the percentage length of the shortened antenna (20 feet) to the full size antenna (66 feet) so (20 / 66 = .3030 or 30%) and B – the percentage of the distance of the coil from the feed point (3 feet) to the total antenna length (20 feet) so (3 / 20 = .15 or 15%). Plugging the values into the table gives an estimate of 1,600 ohms of inductive reactance (XL).

Using the reactance nomograph on page 27 of the Electronics Data Book with the frequency (3.55 Mhz) and XL reactance (1600 ohms) gives an approximate value of 70 uH for the loading coil which is a close fit for the larger B&W coil I had found.

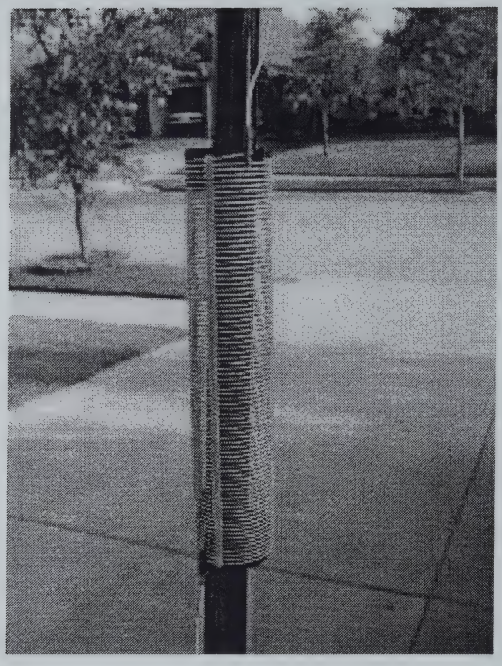
For this antenna then: the operating frequency is 3.55 MHz, the total antenna length is 20 feet, the loading coil is about 1 foot long and located 3 feet from the feedpoint, and the length above the loading coil will be (20 – 4 =16 feet). The loading coil is about 70 uH to load the 20 foot vertical to 3.5 MHz.

Because the antenna is very short at 3.55 MHz and the radiation resistance will be very low, I decided to use inductive shunt matching at the base to match the antenna feed point to the 50 ohm coax. I didn't calculate the shunt coil value, I just used a piece of coil stock that "looked big enough".

Construction

I used the B&W coil stock which was about 12 inches long, 2 inches in diameter @ 8 turns per inch as the loading coil. The shorter piece of coil stock, 2 inches long, 10 turns would be the shunt coil.

Mechanically, the loading coil is mounted above the first telescopic junction of the pole using two small pieces of foam pipe insulation for support.

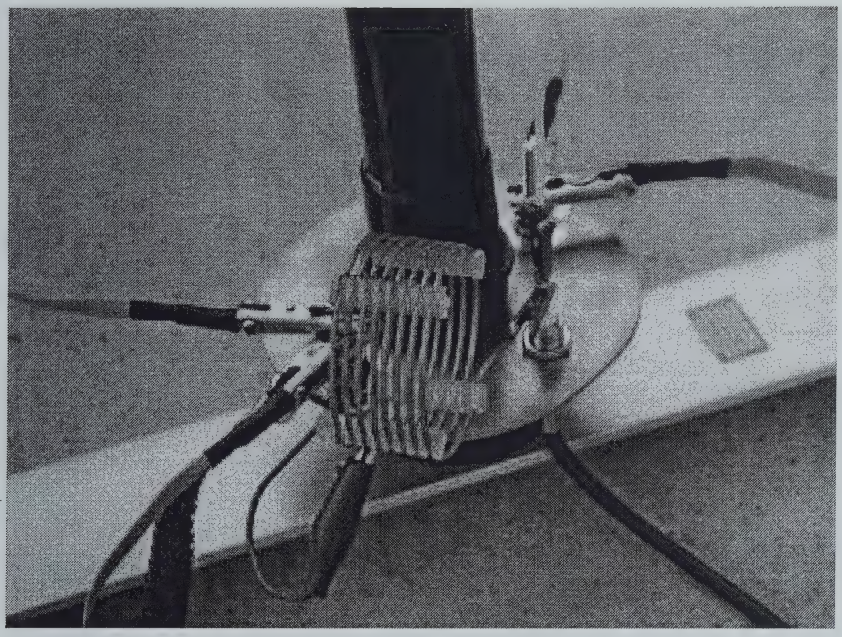


Coil

The 36 inch wire between the feedpoint and the bottom of the loading coil has small alligator clips on both ends to allow connection and tap onto the coil. The top of the antenna is a 196 inch (16 foot) wire supported from the tip of the pole with a small alligator clip on the bottom to connect to the top of the loading coil.

The base and feedpoint of the antenna is a circular copper PCB disk with a BNC connector for attaching the coax and several studs for attaching radials and other ground connections.

The shunt coil is about 7 or 8 turns connected between the BNC center pin and tapped to ground.



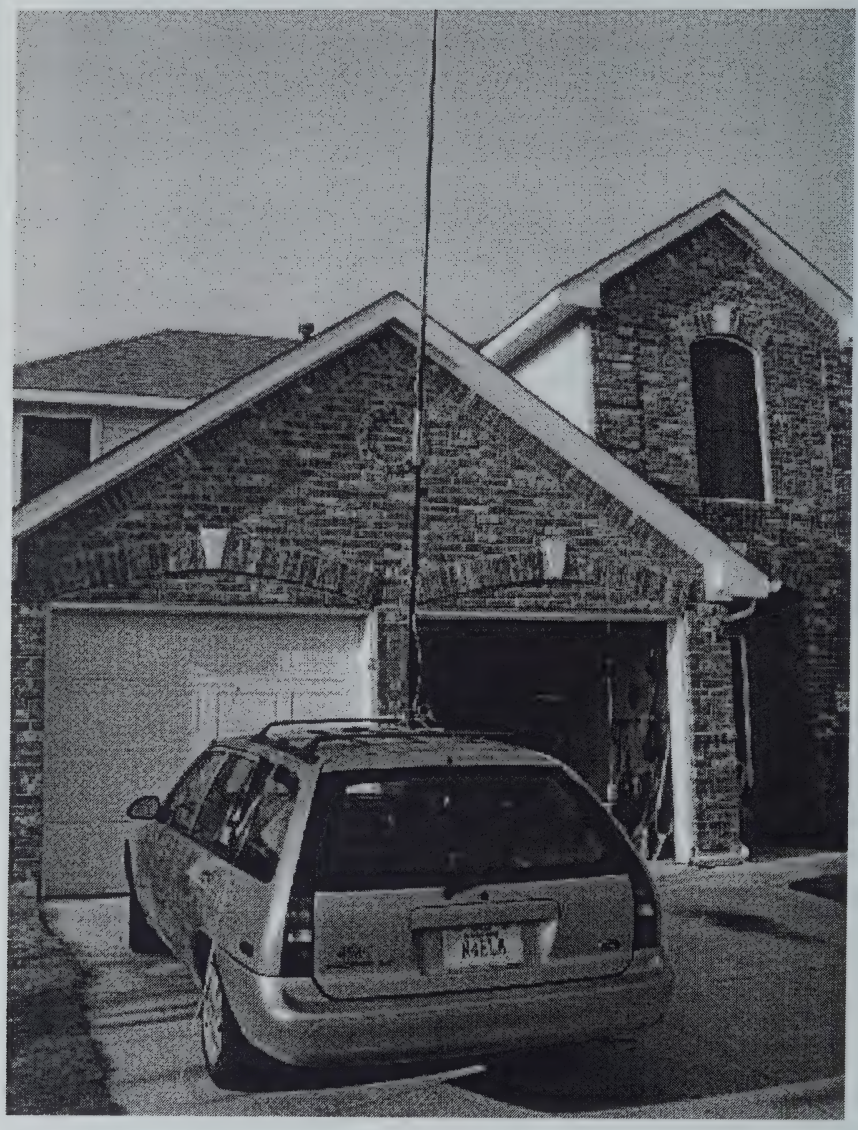
Antenna Base

The entire pole, antenna, and feedpoint assembly is supported by the large four magnet mount on top of the car. A ¼ inch threaded rod secures a 12 inch long, 1 inch diameter fiberglass rod to the mag mount. The SD-20 slides over the rod and traps the feedpoint disk. While this is a sturdy mount and had no problems supporting the antenna, it would not be a good idea to try and drive down the highway with the SD-20 pole attached J

This is a quarter wave antenna, so some sort of counterpoise connection will be needed. After initial testing with the mag mount, I connected four St. Louis Radials to the studs on the ground disk. This provided more consistent tuning and a better match to the antenna.

Tuning

Initial tuning was performed using an MFJ-259 antenna analyzer with the antenna mounted on the car. I started with the maximum turns on the loading coil and the shunt inductor



Yard Art

and radials disconnected.

I tapped down the coil until the minimum SWR dip shown by the analyzer occurred at 3550 KHz. The SWR dip coincided with the reactance dip which I took as a good sign.

Then I added the shunt inductor and adjusted its tap for

an SWR of 1:1 on the analyzer.

Adding the 4 radials shifted the resonance point down about 100 kHz, so the coil tap was moved to bring it back up to 3550 kHz.

I disconnected the analyzer and connected the FT-817 to the antenna through a cross needle SWR/wattmeter and the SWR dipped to 1:1 within a couple of kHz of the analyzer reading.

The 2:1 SWR bandwidth was very narrow, about 25 kHz, which seemed reasonable for a very short vertical.

Results

After dinner on Friday night, I parked in the corner of the Guesthouse parking lot and set up the antenna. With the FT-817 running about 4.5 watts I was able to check into the round table and worked 3 or 4 stations located between McKinney, Sherman, and Bonham Texas for about 45 minutes. Receive signals were reasonable and I got several favorable comments about my signal.

Dave Redfearn, N4ELM

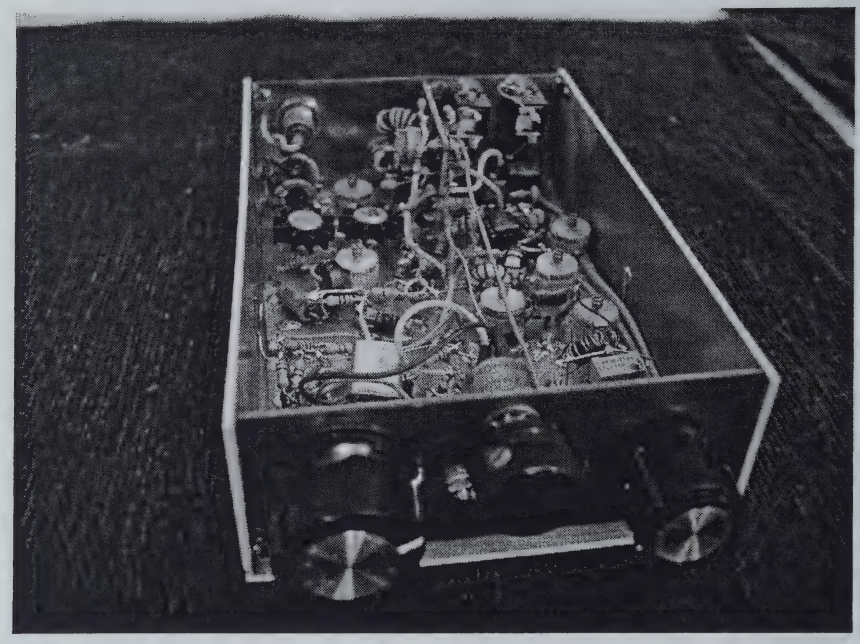
NB6M 10 A Homebrew 10 Meter Transceiver

by Wayne McFee, NB6M

What started out as a simple VXO experiment has snowballed into the building of a complete 10 Meter QRP CW Transceiver. The rig tunes from 28.001 through 28.088 MHz, covering a good portion of the lower end of the band and including both the common DX frequencies and the 10 Meter QRP calling frequency.

A 14 MHz VXO, followed by a frequency doubler and a double-tuned bandpass filter, provides a stable 28 MHz signal source for the transmitter, and, with a frequency offset scheme utilizing RIT, acts as the direct conversion receiver's local oscillator as well.

Because of the inherent non-linearity of a wide-band



VXOs tuning, the RIT is not linear across the tuning range. However, the RIT circuit shifts the 28 MHz signal 1 KHz at the upper end of the VXOs'tuning range and about 2.7 KHz at the low end. In practice, this has proven to be sufficient, as it is easy to adjust the RIT knob for whichever received tone is preferred by first zero beating the received signal through the use of the "spot" switch and then adjusting the RIT as desired.

The transmitter puts out about 1.5 Watts, and the receiver, a simple direct conversion design lifted from Wes Hayward, W7ZOI's, updated Micro Mountaineer, is sensitive enough to hear all but the weakest of signals.

A Tick keyer was included, both to provide the keying function and to provide sidetone, which is introduced into the receiver's audio output.

I started out working with a simple crystal oscillator, using a common 2N2222 and a pair of 14.060 MHz crystals.

After a bit of experimentation, and switching from a pair of cheap silicon diodes to a 1SV149 tuning diode, the VXO tuned from 13.990 through 14.044 MHz. The addition of a resistor in the ground lead of the tuning pot, selected in value to set the lower end of the tuning range just above 14000.5 KHz, prevents out-of-band operation.

Obviously, the fundamental tuning range of this VXO would be quite useful on 20 Meters, as well, but since I had already built a push-push frequency doubler for another project, and had wanted to try QRP on the 10 Meter band, I chose to use the VXO as part of an all homebrew Ten Meter CW rig.

Although the peak of the sunspot cycle has passed, there are still sufficient band openings and enough activity to warrant putting the rig on 10 Meters, and on-the-air results have more than justified the small amount of work and low cost of building the rig. Since I keep a fairly extensively stocked "junk box" of parts, I had all the parts needed for the rig already on hand.

Once the RIT circuit was added to the VXO, the signal was routed to a JFET buffer amp and push-push frequency doubler, on to a driver stage utilizing the metal case 2N2222A, and then to a single-ended power amplifier using a cheap and readily available 2N3053.

However, there were a couple of drawbacks to overcome. First and foremost, the signal purity was not good. Too much of the fundamental was getting through the transmitter, no matter how carefully the push-push frequency doubler was balanced. And, although the three quarters of a watt a single 2N3053 produced is sufficient power output for many contacts on 10 Meters, the PA transistor was running too hot.

Adding a double-tuned bandpass filter between the frequency doubler and the driver stage cleaned up the signal nicely. Adding a second 2N3053 in parallel with the existing PA gave about a Watt and a half of power output and cool

running of the transistors.

With the transmitter basically finished, and having a 28 MHz local oscillator signal readily available, the addition of a Direct Conversion receiver to turn the rig into a complete transceiver was a natural. Having wanted to try out the simple receiver design by Wes Hayward, W7ZOI, published in his July 2000 QST article on an updated Micro Mountaineer, I welcomed the opportunity to couple that receiver with the finished transmitter.

In my conversion of an SMK-1 to 20 Meters, I had found that an RF preamp was a necessary addition if one were to reliably hear weak signals on that band, with the NE602 and LM386 in a configuration similar to the MRX40 receiver. Wes, W7ZOI, had reported in his article on the updated Micro Mountaineer that the simple NE602/LM386 receiver in his rig copied a .1 uV signal. This was the primary factor resulting in the choice of using his design in this rig for 10 Meters. If the addition of an RF Preamp for the receiver was unnecessary, the rig could be kept simpler.

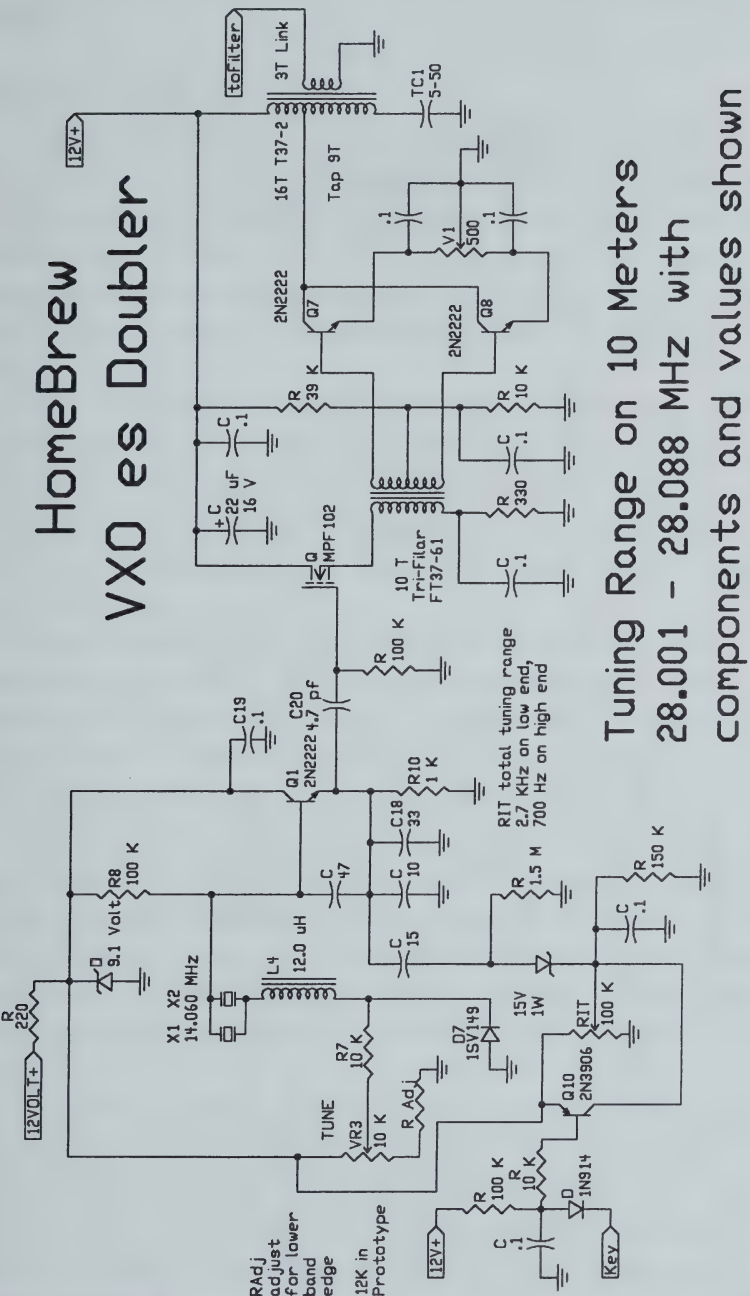
The SA612 Mixer is still manufactured by Phillips, and the other parts and transistors used to build the rig are commonly and cheaply available. Many of the parts are available from your local Radio Shack store.

All resistors used are ¼ Watt. All the .1 bypass caps in the rig are monolithic. The .01s and .001s used were disk ceramic. NP0 caps were used in all the frequency determining parts of the rig, and Silver Micas were used in the transmitter's output filter. I have not included a parts list, but with each stage individually detailed, a parts list is easily made up as construction progresses, stage by stage.

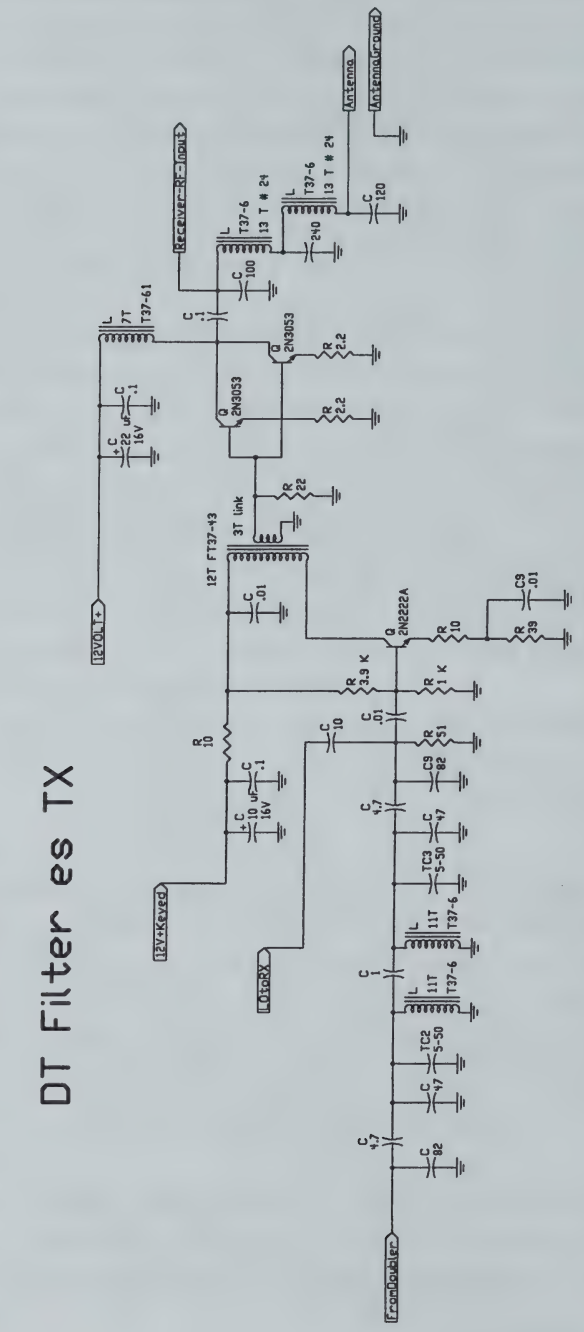
THE CIRCUITS

The complete transceiver's circuit is divided into three parts, here, for easier viewing. The three sections are designated VXO and Doubler, Filter and Transmitter, Receiver and Keying.

Here is the circuit for the VXO, Buffer and Frequency Doubler:



The Double-Tuned Bandpass Filter and Transmitter:



And finally the Receiver and Keying circuitry: Note this schematic is contained in the Insert Section in order to show it clearly.

BUILDING THE RIG

Except for the few Manhattan style pads glued down in order to mount a socket for the SA612 mixer IC, those few that are used to insulate contacts of the various trimmer capacitors, and a few in the Tick Keyer circuit, the entire remainder of the rig was easily and quickly built "Ugly" style, over the continuous copper ground plane of single sided PC board.

If you have not yet tried this method of building, let me just say that this is the easiest and fasted building method I have used. That, coupled with the fact that RF circuits built this way operate better and cleaner over that continuous copper ground plane than they do in a PC board, makes "Ugly" even better.

Sure, I know there is no PC board and photo layout to follow. You just start at the natural beginning of a circuit, in this case the VXO, start with a part that solders directly to ground, such as the 1 K resistor in the emitter lead of the VXO transistor, cut one lead, bend it at 90 degrees, solder it to the ground plane with the body of the resistor standing straight up, and continue installing parts, alternating between the legs of parts that go to ground and legs of parts that attach to the upper legs of parts that are grounded. You will be amazed at how fast and easy this is, and who cares if it isn't perfectly symmetrical or if there is no part label on the "PC" board.

If you run out of room in one direction on your PC board base, turn the corner and keep going. Or build part of the circuit on another board and tack solder them together. Think of how small a rig you can build if you put part of the circuit on the bottom, part on the sides, and part on the top of an all PC

board equipment case.

Because you have the choice of either building the complete circuit on one continuous sheet of PC board material that will end up being the bottom of your PC board material case, or building the circuit in sections, on small pieces of PC board material that can be tack soldered wherever your layout requires, this method is very flexible and lends itself quite readily to circuit changes, especially at the stage and module level.

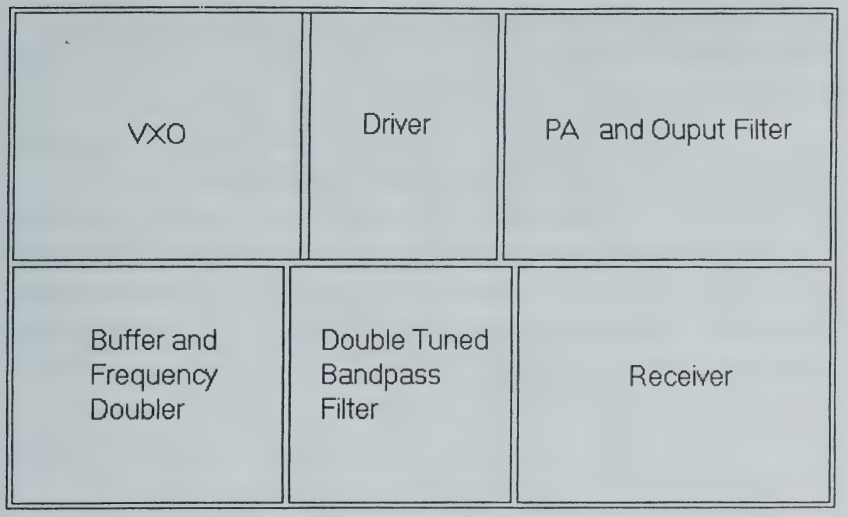
Short pieces of hookup wire form the 12 Volt supply lines, and either short pieces of shielded wire or hookup wire connect the controls, switches, and the RF, power and earphone connectors to the circuit.

No high value resistors were used as standoff insulators, and no insulated soldering pads cut from PC board were needed other than those few previously mentioned. There are enough parts soldered directly to ground, and there is enough rigidity in part leads, to ensure that the components are mechanically stable without their use.

The main tuning pot, the RIT and RF Gain controls, and the two push-button switches for programming the Tick Keyer and Spotting the transmitter frequency are mounted on the front panel. The rear panel has the power connector, BNC RF output jack, and the paddle and headphone jacks.

The drawing below shows the general layout of the circuit as built on the PC board bottom of the case. Only the Tick keyer is on a small, separate board, which is tack soldered vertically to the rear panel of the PC board case.

In this layout, the finished size of each section is entirely up to the builder, as is the finished size of the whole. With this layout, the signal starts in the VXO, goes to the Buffer and Frequency Doubler, through the Double Tuned bandpass filter, and from there to both the transmitter driver and the receiver mixer. The input side of the transmitter driver faces the DT filter, as does the mixer side of the receiver, facilitat-

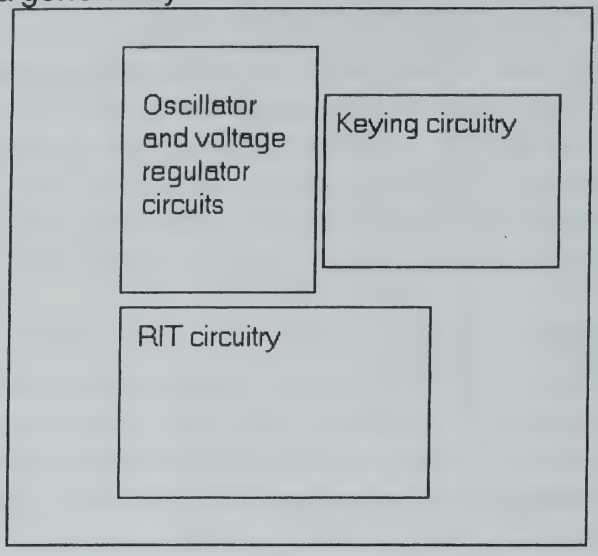


NB6M 10 Suggested layout

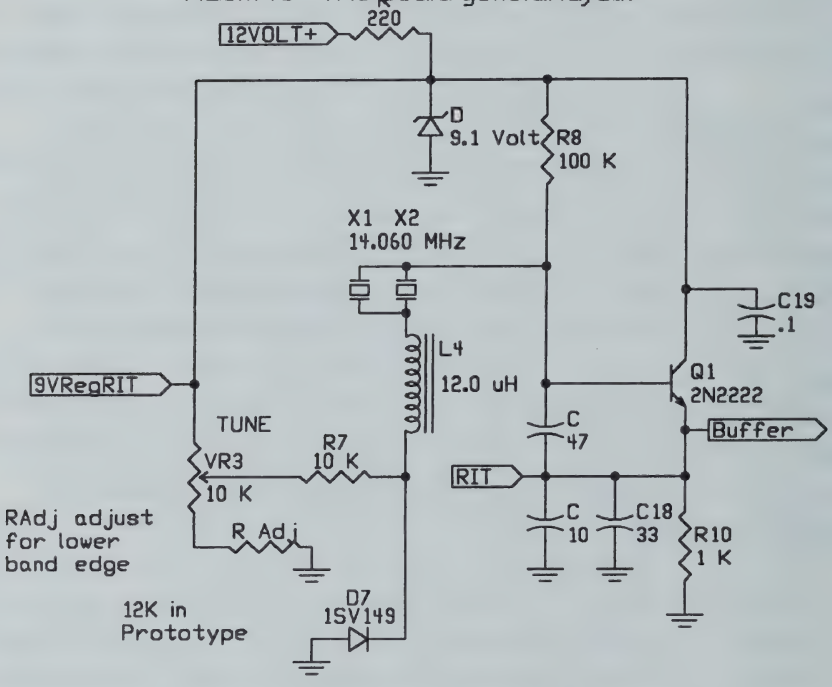
ing easy connections.

Use silver content solder, both for the stronger and cleaner solder joints it makes and for the reduction in lead exposure. I use two soldering irons of differing wattages, a low wattage iron for attaching parts to each other, and a medium wattage iron for soldering either parts or PC board sections to the PC board base. There is no need to bend part leads around each other. They should be touching, and the nice clean flow of a small amount of solder should cover their junction. If the first two parts are joined in this manner, it is easy to re-heat the joint and add each next part lead. You will quickly learn that having the far end of previously installed parts already soldered to their adjoining parts will prevent the junction you want to add to from falling all apart when you re-flow the solder.

Here is a general layout of the VXO section of the "board".



NB6M 10 VXO board general layout



NB6M 10 VXO

Build the VXO first, starting with the oscillator itself, from the emitter up. Leave about ¾" of free space on the board to the left of the VXO, which will be the front of the rig, so that the parts will clear the tuning pot and other controls.

Once the oscillator is built, including its voltage regulator, the "ground" leg of the tune pot, or a substitute, can be soldered directly to the edge of the board, the wiper is connected to the 10 K resistor leading to the tuning diodes, the top leg of the pot is connected to the top of the 9.1 volt Zener, and the oscillator can be tested. Either listen for its output in a receiver, or check its output with an RF voltmeter and frequency counter, at the emitter of the transistor.

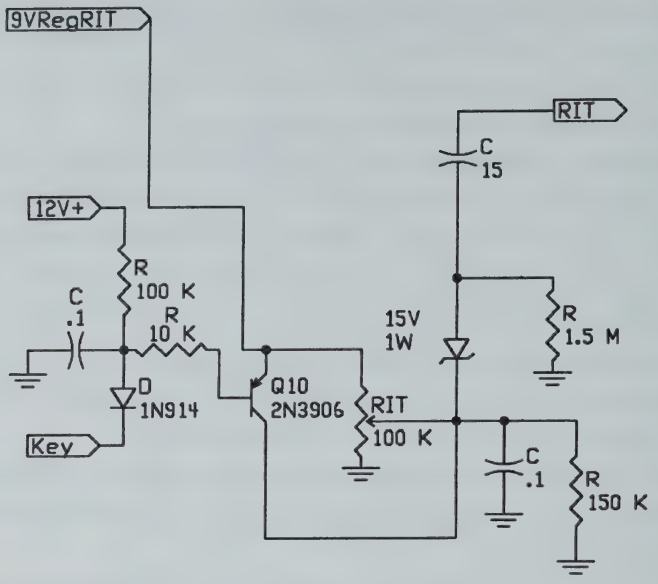
The signal should be quite strong in a nearby receiver, and with the components listed, you should get 40 KHz or more of tuning range.

In my rig, the initial tuning range was 13.990 to 14.044 MHz. I put a 12 K resistor between the ground leg of the Tune pot and ground in order to fix the lower end of the tuning range just above the bottom of the band.

However, wait until the RIT circuit is installed before installing R-Adj, as it is labeled in the RIT Circuit, as that will slightly change the tuning range of the VXO.

Once you are satisfied the VXO is working properly, disconnect the power source and install the entire RIT circuit, beginning with the 15 pf cap that attaches at the junction of the oscillator transistor's emitter and the tops of the 1 K resistor, and the 33 and 10 pf caps. For the time being, the cathode of the 1N914 that will attach to the "key" line is left floating, unconnected.

Here is the RIT circuit:



NB6M 10 RIT

Solder a cutoff part lead to one end leg of the RIT pot, and solder a couple of three inch long pieces of hookup wire to the other two legs. This way, the RIT pot can be connected to the circuit in order to test the RIT and TX frequency offset functions. The wiper of the pot connects to the cathode end of the 15 Volt Zener used in the RIT circuit. The leg of the pot opposite the ground leg is connected to 9.1 volts regulated at any convenient spot in the oscillator circuit.

Once the RIT pot is connected, apply 12 volts to the VXO circuit again, either hook a frequency counter up to the emitter of the oscillator transistor or listen to the second harmonic of the VXO in a nearby receiver, and check the function of the RIT. At the low end of the VXO tuning range, the RIT should change the 28 Mhz harmonic a total of about 2.7 KHz. At the upper end, it should provide about 1 KHz of total frequency change.

Then, with the RIT pot centered in its travel and the VXO at the low end of its tuning range, use a test lead with alligator

clips on each end to ground the cathode of the 1N914 that will eventually connect to the "Key" line. With it grounded, the VXO frequency should shift, and in this case about 1 KHz or so.

The exact amount of frequency shift depends on the position of the RIT control. At one end of the RIT knob's travel, there will be no frequency shift when the key line is grounded. At the other end of the RIT pot's travel, with the VXO at the low end of its tuning range, the frequency will shift about 2.7 KHz.

In my rig, the Tune pot is connected so that the VXO's frequency goes up as the pot is rotated clockwise, and the RIT pot is connected so that no shift occurs when the pot is turned all the way clockwise.

In practice, if one desires to listen to the same received tone throughout the entire tuning range of the rig, the received signal is zero beat while holding the "spot" push-button switch in, and then the "spot" switch is released and the RIT knob adjusted for the desired reception tone.

With this arrangement, popularized by Roy Lewallen, W7EL, in his "Optimized QRP Rig", one listens to the upper sideband of any received signal, in order to place the offset transmitter signal on frequency in the other person's receiver. Holding the "Spot" switch in while tuning the received signal to zero beat will ensure that the transmitted signal is exactly on the received frequency. Substituting a SPST toggle switch may make tuning easier, as the RIT can be switched off while tuning, then switched back on, without having to hold a push-button style switch in while doing so.

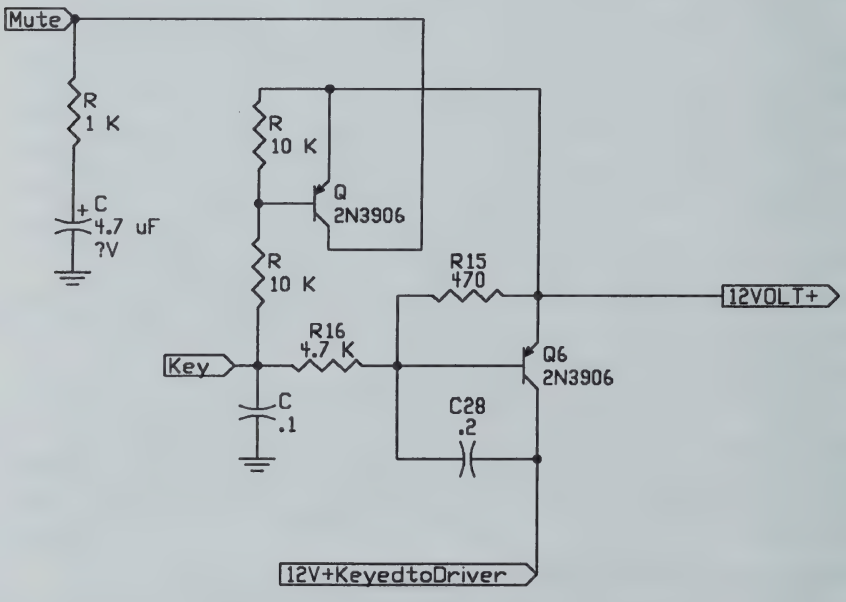
Now that the RIT Circuit is installed and working, it is time to install the resistor, Radj, that determines the lower end of the tuning range. Assuming your VXO tunes below the bottom of the band, R-Adj will be needed so as to prevent out-of-band transmissions.

While either monitoring with another receiver or with a

Frequency Counter, tune the VXO just above the bottom of the 20 Meter band, say around 14000.5 KHz. Disconnect the power from the VXO, unsolder the wire connected to the wiper of the Tune pot, and, being sure not to turn its knob, measure the resistance from the wiper leg of the pot to ground. The resistance measured will be very close to that amount needed to keep the VXO from tuning below the bottom of the band. Install the next larger common value of ¼ Watt resistor between the ground leg of the pot and ground, and re-connect the wire to the wiper.

Test the tuning range of the VXO to be sure it doesn't tune below 14000.0 Khz. As we will be transmitting the upper sideband of the VXO frequency, doubled to 28 MHz, this will ensure that we stay within the band with our transmitted signal. Just to be sure, re-check the low end of the tuning range while listening to the 28 MHz harmonic of the VXO.

Add the keying circuitry next, in its designated general area in the VXO section of the "board". Here is its circuit:



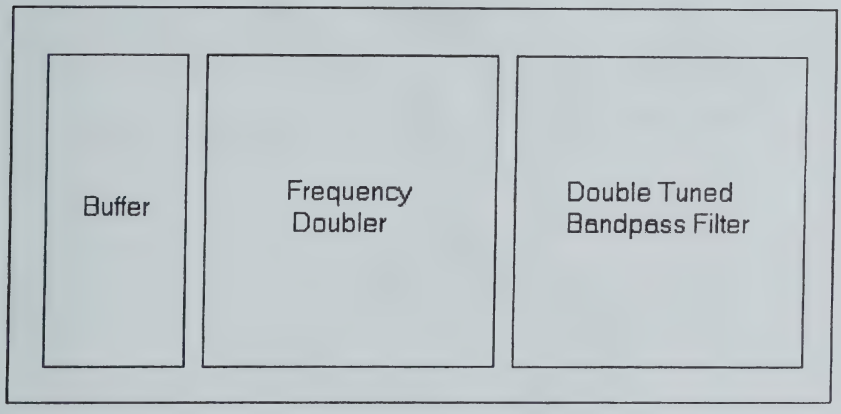
NB6M 10 Keying

In actuality, the 12 Volt "Bus" wiring will eventually run directly from the 12 Volt power jack to the PA stage and then on to the other various stages that require it, so, at present, the 12 Volt connection shown here is the same point as the 12 Volt connection for the VXO. The 12 Volts Keyed line to the driver will be added after that stage is built.

Once the keying circuitry is built, and 12 Volts applied, it can be tested by measuring the voltages on the Collectors of both keying transistors, as it will be 0 Volts when the rig is in "Receive" mode, and 12 volts when the Key line is grounded in "Transmit" mode.

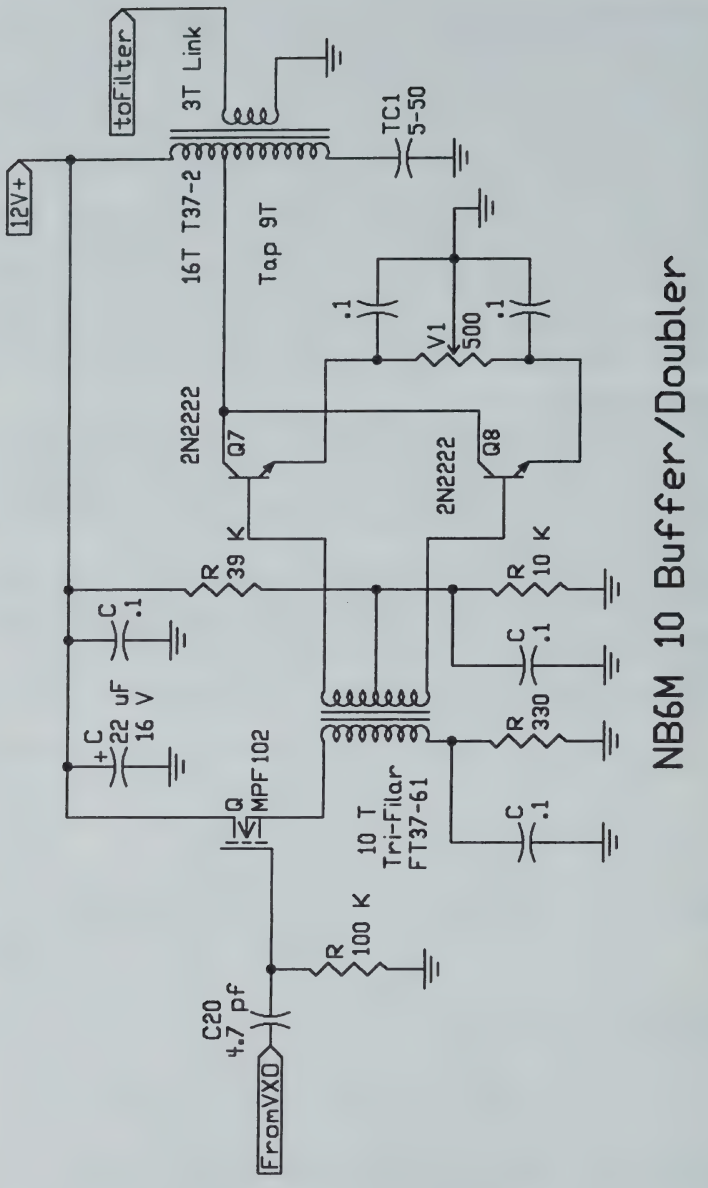
The Key line connection shown here is connected to the Key line contact in the RIT circuit, and will be connected to the Key line contact in the Tick Keyer circuit, once that is built and added to the rig.

The general layout for the JFET buffer amp, Push-Push pull frequency doubler and double-tuned bandpass filter is as follows:

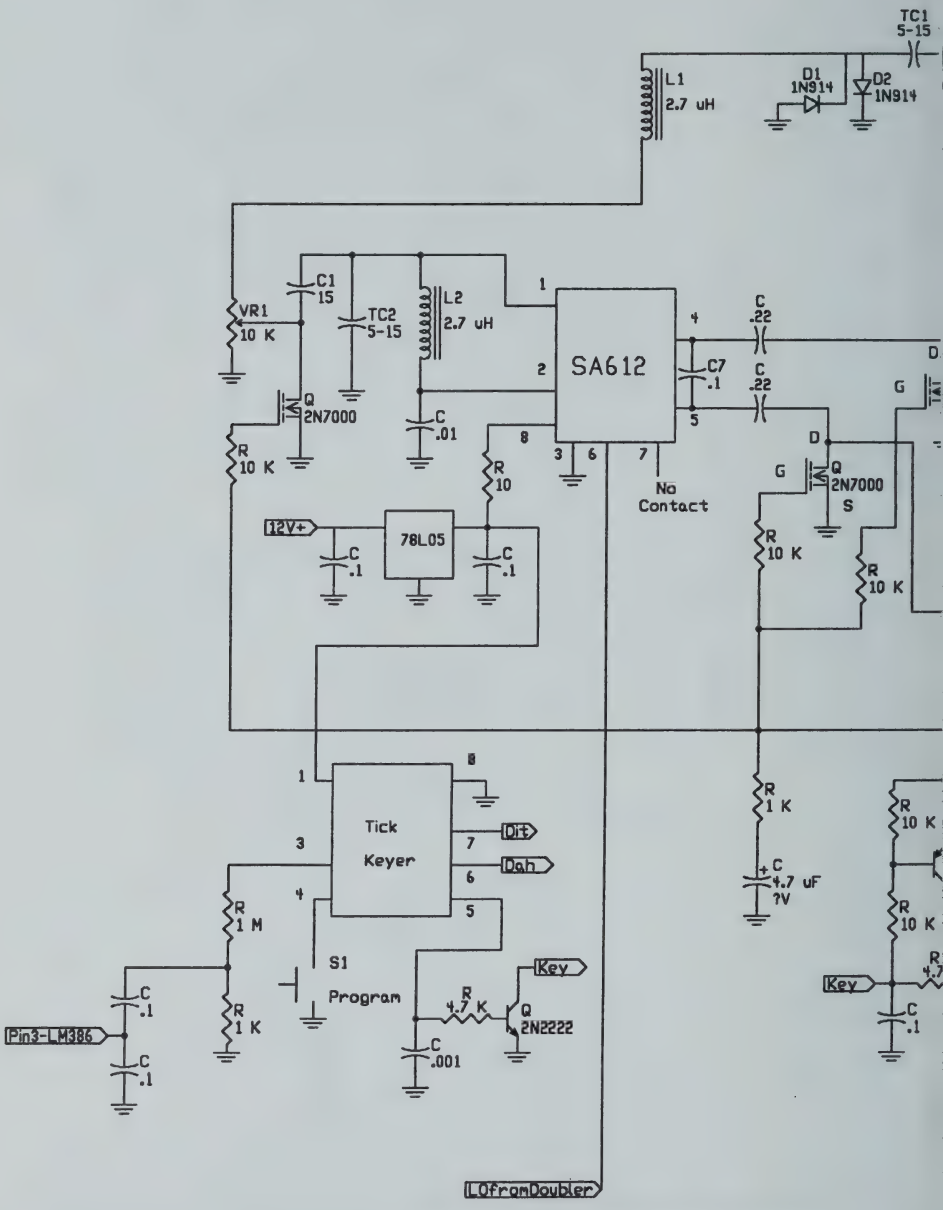


NB6M 10 Buffer, Doubler and Double Tuned Bandpass Filter general layout

Next, build the JFET buffer amp and the Frequency Doubler. Here is the circuit:



Once the buffer and frequency doubler are built, test this stage. Bare necessity test equipment for use in this project should include an oscilloscope, a high impedance voltmeter with RF probe, a receiver capable of receiving both the 20

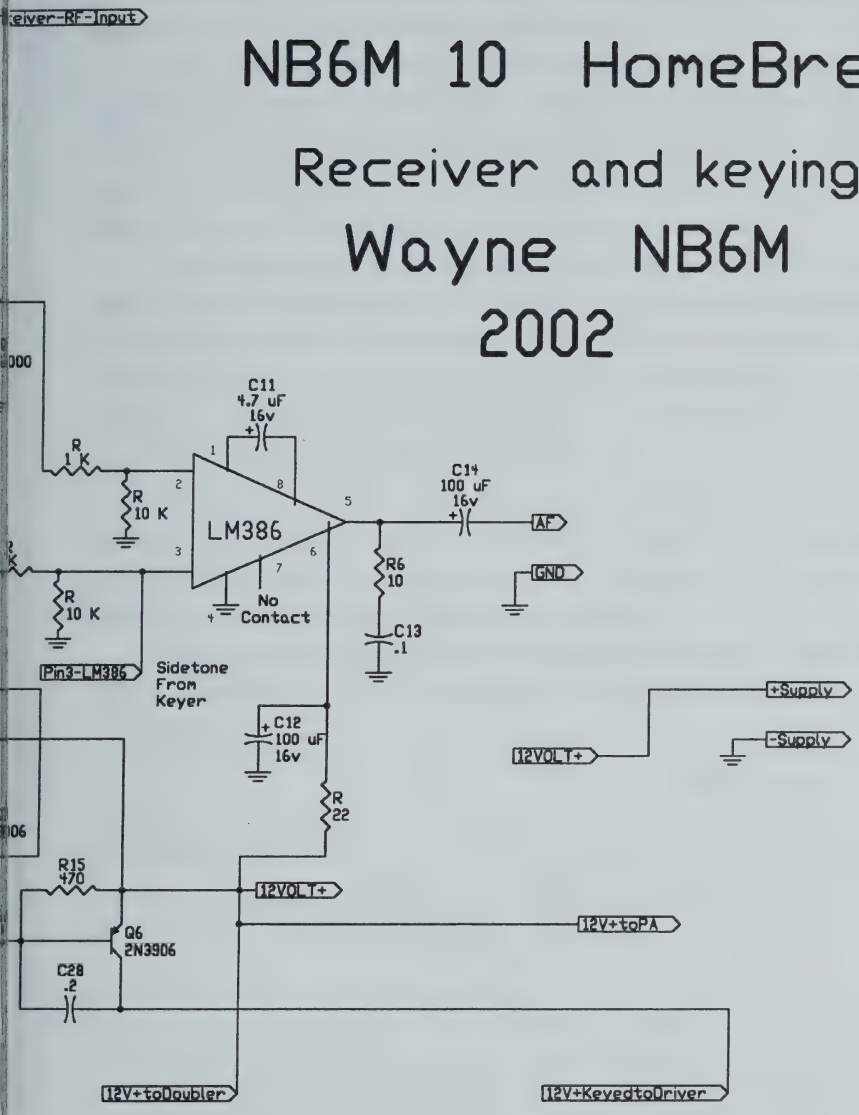

TC1
5-15
L1
2.7 uH
D1
1N914
D2
1N914
VR1
10 K
C1
15
TC2
5-15
L2
2.7 uH
SA612
C
.22
C7
.1
C
.22
Q
2N7000
C
.01
R
10 K
R
10
No
Contact
12V+
78L05
C
.1
C
.1
G
D
Q
2N7000
S
R
10 K
R
10 K
Tick
Keyer
Dit
Dah
R
1 M
S1
Program
R
1 K
C
.1
C
.1
Pin3-LM386
R
4.7 K
Q
2N2222
C
.001
Key
R
1 K
C
4.7 uF
?V
R
10 K
R
10 K
Key
C
.1
LOfromDoubler

NB6M 10 HomeBrew

Receiver and keying

Wayne NB6M

2002



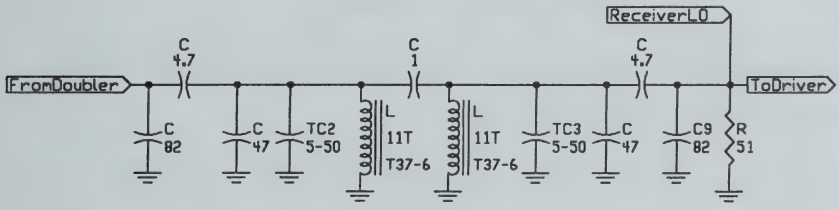
Meter and 10 Meter ham bands, and a 50 Ohm resistive dummy load. A wattmeter helps, but the voltmeter and RF probe will suffice if one is unavailable.

If you don't own an oscilloscope or other pieces of necessary test gear, a nearby ham should be more than glad to help you test and align stages as they are added to the circuit. I certainly extend that invitation to anyone in my area who wishes to build any gear that I can help with.

An oscilloscope is definitely a plus when alignment and adjustment of the push-push frequency doubler is performed, as one first adjusts the trimmer in the doubler output for maximum 28 MHz signal, and then adjusts the balance pot between the emitters of the push-push transistors for a minimum or null of the 14 MHz fundamental.

Either a 51 or 47 Ohm resistor is connected temporarily from the top of the 3 turn link to ground, and the signal monitored there. Once this section is aligned, DC power is disconnected and the resistor is removed.

The double tuned bandpass filter is built next, up to and including the 51 Ohm resistor which serves as its load. Here is its circuit:

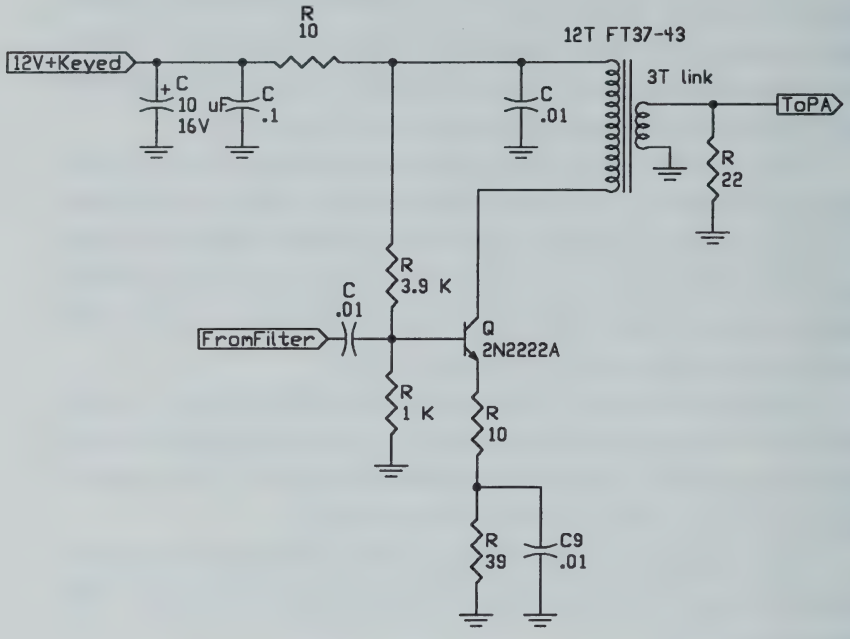


NB6M 10 Bandpass Filter

After re-connecting DC power, the filter is aligned by adjusting the two trimmers for maximum 28 MHz signal, and minimum 14 MHz fundamental, while observing the signal at the top of the 51 Ohm resistor at the output, on an oscilloscope. This adjustment should be performed with the VXO tuned to the center of its tuning range, so as to provide a

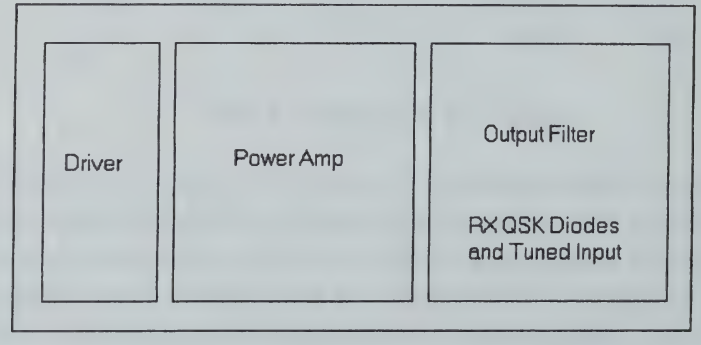
more uniform signal level throughout the entire tuning range.

Build the driver stage next, including the 22 Ohm resistor that goes from the top of the 3 Turn link on its output transformer to ground. Here is its circuit:



NB6M 10 Driver

The Driver, PA, Output Filter, Receiver Tuned input Circuit general layout is pictured below:

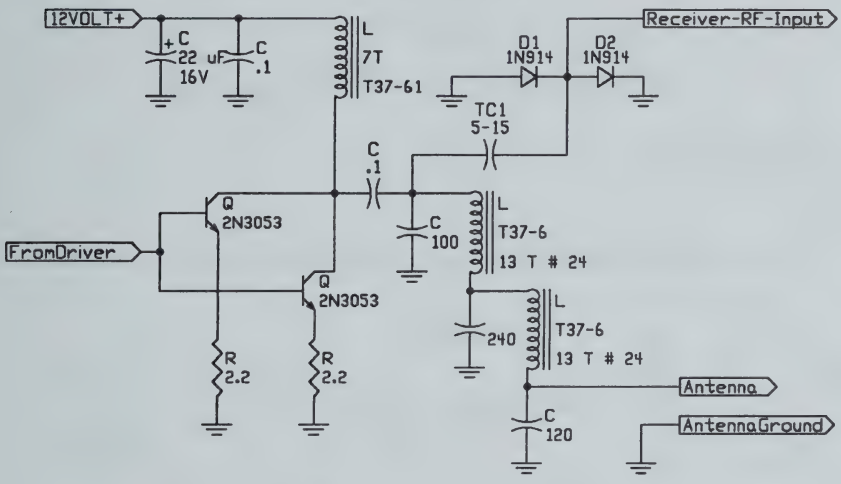


NB6M 10 Driver, PA, Output Filter and RX Input

Connect the 12 Volts Keyed line to the collector of Q6 in the keying circuit. Connect the 12 Volt DC supply line, and test the driver by either listening for an increase in 28 MHz signal in a receiver, by observing the output with a voltmeter and RF probe, or with an oscilloscope while grounding the Key line.

The PA stage and its output filter is built next, and connected to the BNC antenna jack. Include the trimmer TC1 and the two QSK diodes, D1 and D2 in the area of the output filter. Use heat sinks on the 2N3053 transistors.

The PA and output filter circuit is here:

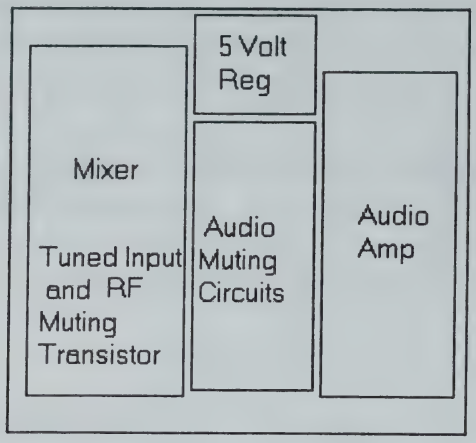


NB6M 10 PA

At this point, the transmitter is complete, and can be tested, by grounding the Key line while the transmitter is connected to a Wattmeter and Dummy Load, or while the output is monitored with Voltmeter and RF probe or Oscilloscope while connected to a Dummy Load.

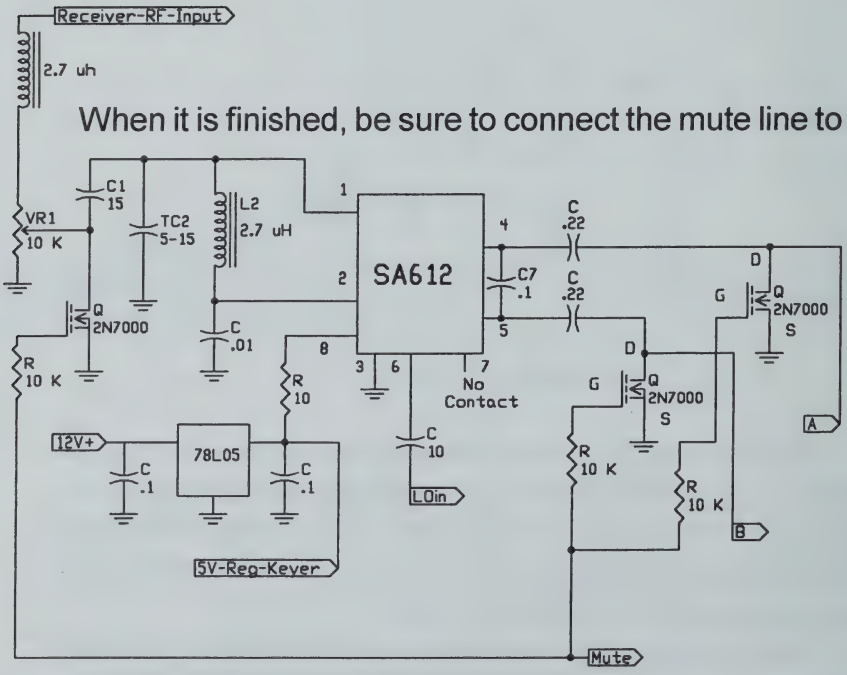
The prototype rig's transmitter produces about 1.5 Watts of output.

Next is the receiver. Here is the general layout for the receiver and its muting circuitry:



NB6M10 Receiver Layout

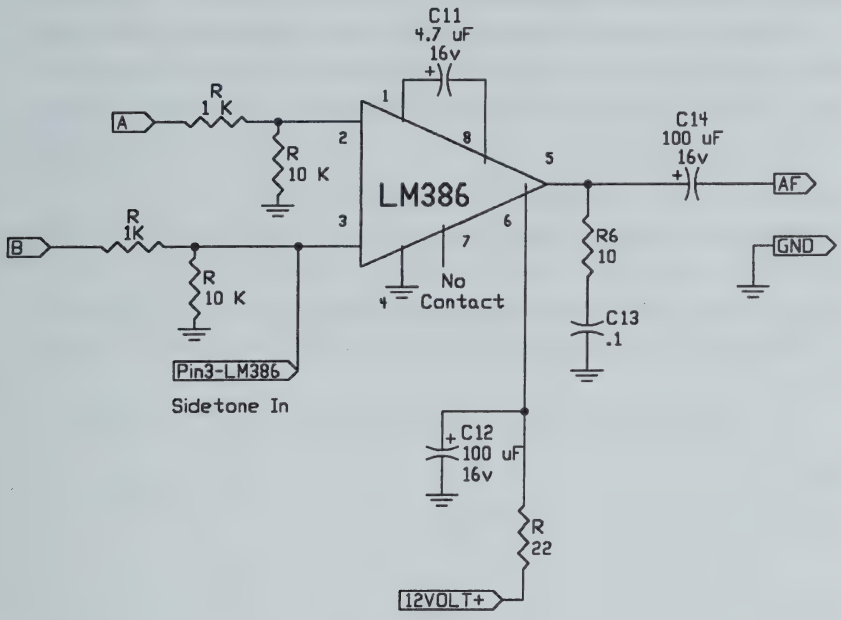
When it is finished, be sure to connect the mute line to



NB6M 10 RX Mixer & Muting

the top of the 1 K resistor in the Keying Circuit, at the point labeled "Mute", and connect the 10 pf cap from pin 6 of the IC to the top of the 51 Ohm resistor in the output of the DT filter.

The Receiver Audio amp circuit follows:



NB6M 10 RX Audio Amp

The RF Gain pot will be mounted on the front panel. Use shielded wires to connect it to both the RF input and the Receiver Mixer.

When the receiver section is complete, with the 12 Volt supply line connected and with an earphone jack connected between the AF output and ground, the receiver can be aligned and tested.

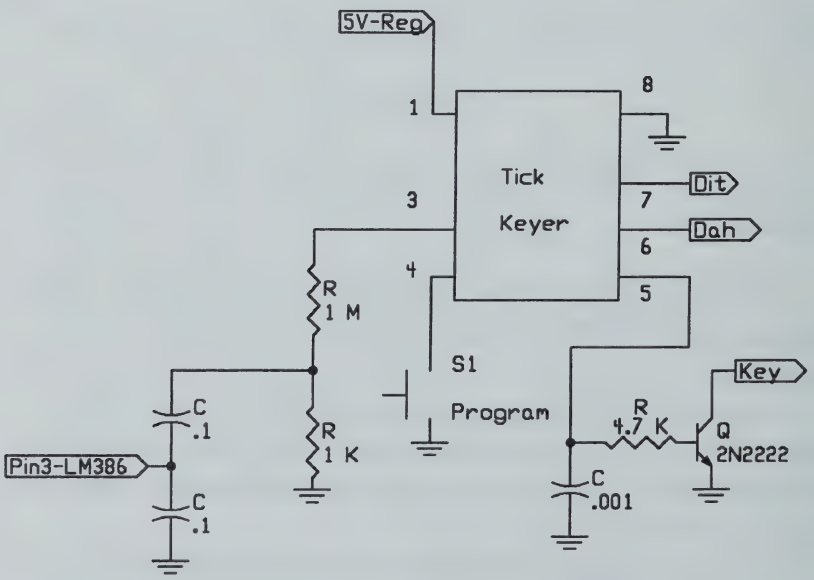
The earphone jack should be wired so that the AF output goes to the "tip" connection of the stereo earphone jack, and the ground connection goes to the "ring" connection.

When the jack is installed in the rear panel of the case, enough of the copper surface is scraped off both the inside and outside surfaces of the panel so that the "ground" connection of the jack is NOT grounded. Wiring the earphone jack this way provides higher audio output from the stereo earphones, as they are connected in series.

With a 10 Meter antenna attached, and while listening to a weak signal, or background noise in the absence of a signal, adjust TC1 and TC2 for maximum signal or noise level.

This receiver is prone to hum when it is out of a case, especially at the highest RF Gain settings. The hum should disappear or be greatly reduced when the rig is enclosed in a shielded case, and the hum can be carefully tuned out or much reduced, if still there, by careful adjustment of TC1 and TC2 in order to achieve best signal level with the least amount of hum.

The last section to be built is the Tick keyer. Here is its circuit:



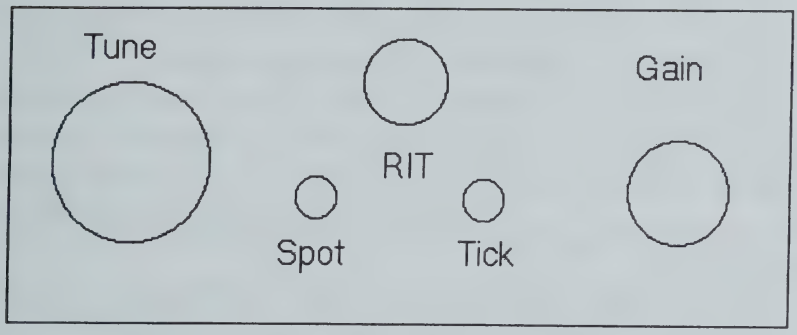
NB6M 10 Keyer

I built the keyer circuit on a small piece of double sided PC board that I tack soldered vertically to the inside surface of the rear of the case, near the top, between the Paddle jack and DC Power jack. This facilitated making its connections to the Paddle jack, receiver audio stage, and to the 5 Volt regulator. A piece of hookup wire connects the collector of the keying transistor to the Key line in the keying circuit.

Now it is time to build the front and rear panels of the case, and ensure that all the connections between stages are properly made.

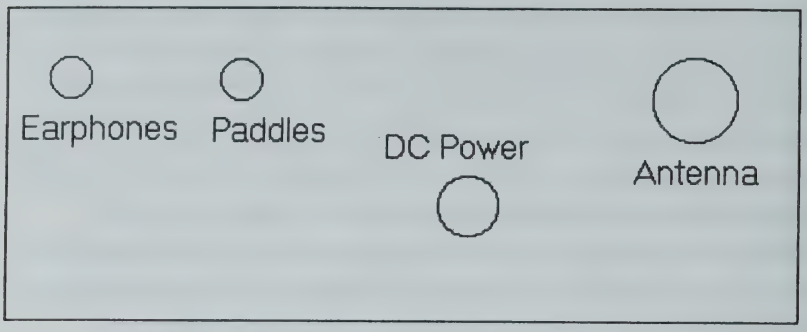
Use the three general circuit diagrams as a guide to make sure all interconnecting lines are properly installed.

Here is a drawing of the NB6M 10's front panel arrangement:



NB6M 10 Front Panel Layout

The rear panel layout is as shown here:



NB6M 10 Rear Panel Layout

The actual size of these panels is determined by the finished size of your layout, and can be cut accordingly. Use double sided PC board for the front and rear panels, and install them about an eighth of an inch inside the edge of the PC board base, so that they can be tack soldered on both the inner and outer bottom edges.

Before installing the side panels, make all connections to the various jacks, switches and potentiometers.

Then, cut and install the side panels, tack soldering them to the front and rear panels. Once the side panels are installed, and all final connections made, Readjust TC1 and TC2 in the receiver circuit for maximum signal gain and minimum or no hum.

Cut and install the top of the case, tack soldering it to the front and rear panels, and the rig is ready to use.

FINAL THOUGHTS

Although it is nearly impossible to exactly duplicate the layout of a circuit that is built "Ugly" style, it should be noted that exact duplication is not necessary. Stages can be built on individual pieces of PC Board, or not, as the builder desires. The size of the project is also up to the builder. If one is used to building only on PC boards, with exact parts place-

ment, this may seem daunting. However, ease and rapidity of construction coupled with clean RF operation of the circuitry and flexibility of layout and final project size and shape more than make up for the lack of a PC board and exact parts layout.

As always, building any project stage by stage, and testing each stage as you go, helps a lot.

This rig could certainly benefit from a more refined receiver. However, adding a simple DC receiver made this transceiver come together quickly and easily, and this receiver is adequate for many contacts. A DC receiver capable of single signal reception, such as the Mini-R2 would be a great alternate choice.

None of the parts used are unique or exotic. While the SA612 mixer ICs are getting scarce, with only Phillips manufacturing them, they are still available.

It is interesting how one simple ham radio experiment leads to so much more, in this case resulting in a fun little rig for a band that is not receiving as much attention, operation wise, as it should. In the short time since building the rig, contacts have been made across the United States and Canada, and several exciting DX contacts, including several in Europe, have been made as well.

It is my hope that some of the ideas presented here in this rig will provide the impetus for building projects of your own. The rewards, both in terms of learning and in the simple joy of operating a rig that you have built from scratch yourself, are well worth the effort.

Color pictures of the rig that show building details can be seen on the NorCal Web page at:

www.norcalqrp.com

Enjoy.
Wayne NB6M

The NorCal 30 Presentation at Pacificon

by Doug Hendricks

The next big NorCal project will be theNorCal 30 Transceiver designed by Dan Tayloe, N7VE, with board layout and packaging done by Dave Fifield, AD6A. Both of these gentlemen spoke at Pacificon about the new rig. At press time (second week of November) this is the status of the rig: It is finished as far as design goes, and Dan has an ugly style prototype that he has measured and was able to determine the specs from. Dave is about 70% through with the first pass of the board layout, and it looks to be a 4 layer board,which will be a first as far as we know of for a club project.

The target price for the rig is about $100, but we reallycan't price it or take orders until we finalize the designon the pc board. We have to build a few prototypes to make sure that the design transfers from the ugly style of construction to the pc board. While this is not difficult, it is a step that takes time and must be done right.

The following pages show the remarkable specs that Dan was able to achieve with his design. These are the actual slides that Dan showed us all at Pacificon, so this is your opportunity to share in the presentation through the pages of QRPp.

When will we take orders? Hopefully around Christmas time. Be sure to check the NorCal page at www.norcalqrp.com and qrp-l@lehigh.edu mailing list as that is where we will be announcing when we take orders, and how to place them.

The kit will be packaged in a case, and it will be a complete kit. All parts, case, controls and connectors provided.
72, Doug, KI6DS

Norcal 30
High Performance/Low power
30m Transceiver

Dan Tayloe, N7VE

Norcal 30 Novel Features

- High performance Quadrature DC Detector
  - *High Rcvr Sensitivity/Excellent large signal performance*
- Single sided reception with phasing receiver
- 3v low power receiver
- Switching supply minimizes current drain

Norcal 30 Specification Summary

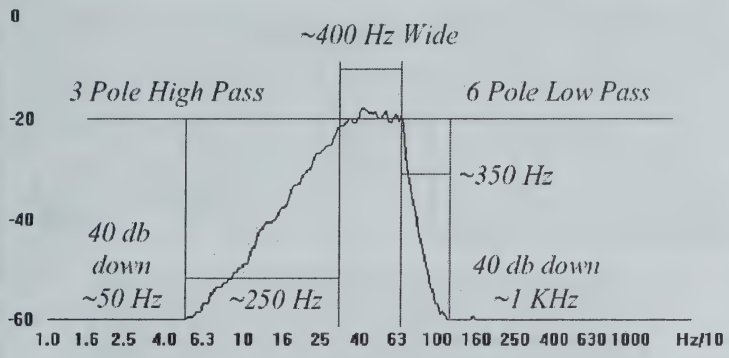
- Receiver Type: Direct Conversion with Phasing
- > 45 db opposite sideband suppression
- Tuning range: 25 KHz, 10.1 – 10.125 MHz
- Receiver sensitivity: -136.5 dbm (0.1 uV), 3 db S+N/N
- Blocking: > +2 dbm
- Blocking Dynamic Range: > 138 db
- Third order intercept: > +25 IP3
- IM Dynamic Range: > 107 db
- No Spurious SW Broadcast AM Detection
- *Rcvr Blocking/IP3 better than practically useful*

Norcal 30 Specification, Cont.

- Transmit: Variable power, 5w max
- Operating voltage: 12v nominal
- Current drain
  - Receive with moderate signal: 13.5 ma at 12v.
    - 10.5 ma at 16v,
    - 18 ma at 9v
  - Transmit, 5w output: 780 ma at 12v.
- Simple RIT provided (0 to ~800 Hz offset)
- TicK keyer
- SSS Audio Frequency Annunciator

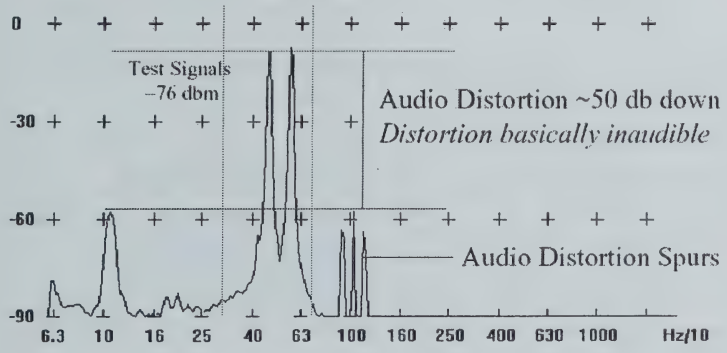
Receiver Audio Response

Measured Using 30m Band Noise



Two Tone Audio IM Response

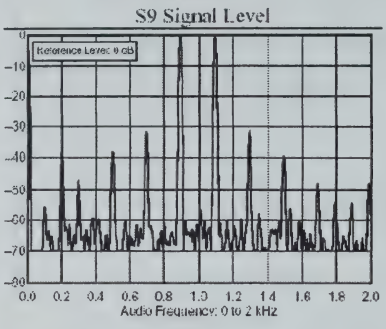
Test demonstrates linearity/clarity of the audio chain



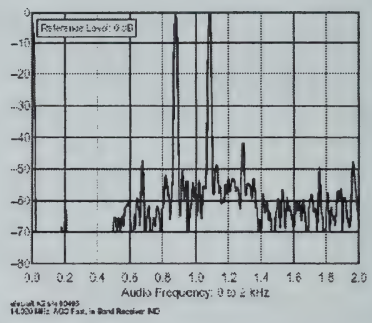
Exceptionally clean audio noise floor

Two Other Audio IM Examples

FT-1000MP



K2



Data taken from ARRL Web Page

Norcal 30 Close in IP3 (low side)

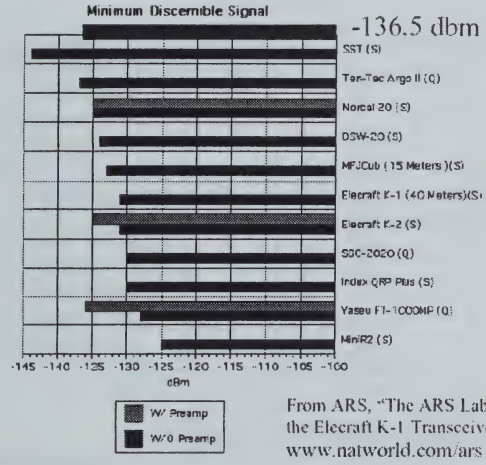
IP3	*IP3 DR*
• +25.0 dbm, 20 KHz	• +107.5 db, 20 KHz
• +14.0 dbm, 5 KHz	• +100.5 db, 5 KHz
• +12.7 dbm, 4 KHz	• +99.5 db, 4 KHz
• +8.2 dbm, 3 KHz	• +96.5 db, 3 KHz
• +3.7 dbm, 2 KHz	• +93.5 db, 2 KHz

Rig Comparisons

- Rig performance data taken from Adventure Radio Society web site.
- The ARS contains a wealth of information comparing the performance of various QRP radios with full size rigs.

www.natworld.com/ars

Receiver Sensitivity

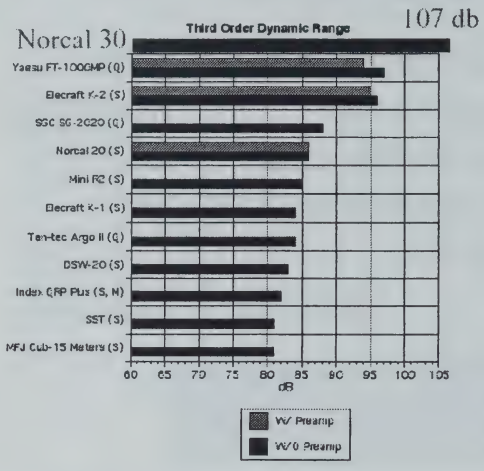


-136.5 dbm Norcal 30

Receiver Sensitivity ranks among the best.

From ARS, "The ARS Lab Reviews the Elecraft K-1 Transceiver" www.natworld.com/ars

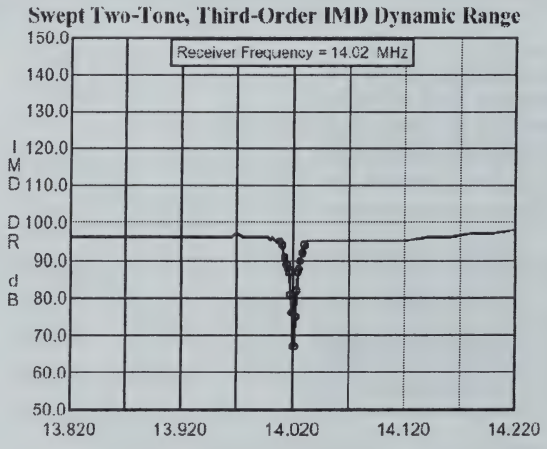
Third Order Dynamic Range



Norcal 30 excels in third order dynamic range.

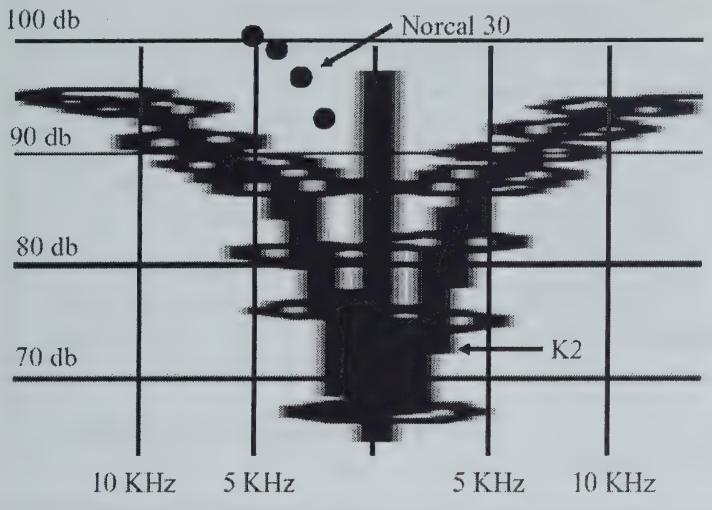
From ARS, "The ARS Lab Reviews the Elecraft K-1 Transceiver" www.natworld.com/ars

K2 – IP3 Dynamic Range



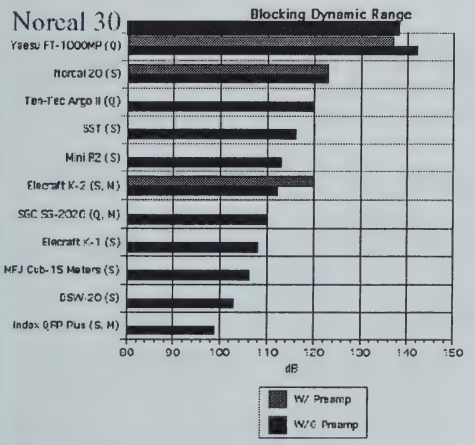
Data taken from ARRL Web Page

Close in IMDR: Norcal 30 vs. K2



Blocking Dynamic Range

Norcal 30



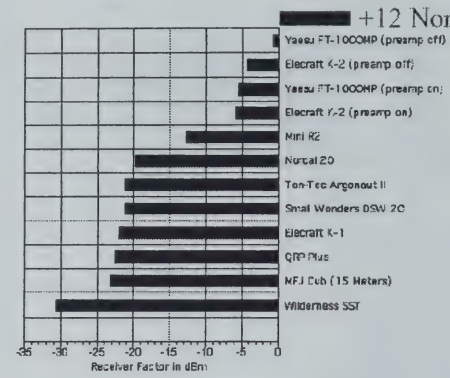
138 db

Blocking Dynamic range is bested only by the FT-1000MP

From ARS, "The ARS Lab Reviews the Elecraft K-1 Transceiver" www.natworld.com/ars

ARS – Receiver Factor

Sensitivity vs. IP3 Tradeoff



From ARS, "The ARS Lab Introduces the Receiver Factor" www.natworld.com/ars

The receiver factor measures the tradeoff between high level signal performance and high sensitivity.

Think of this as the ability to receive weak stations in the midst of high power signals.

Rcvr Factor = IP3 - NF

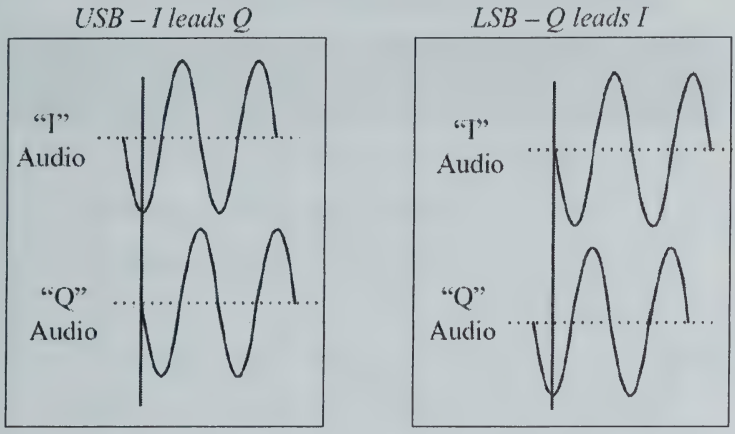
How Does Phasing Work?

- Requires quadrature (I & Q) signals as input
  - *Taken from High Performance Quadrature Detector*
- For Norcal 30 USB Signals:

  I leads Q by 90 degrees
- For Norcal 30 LSB Signals:

  Q leads I by 90 degrees

Picture of Two Sidebands



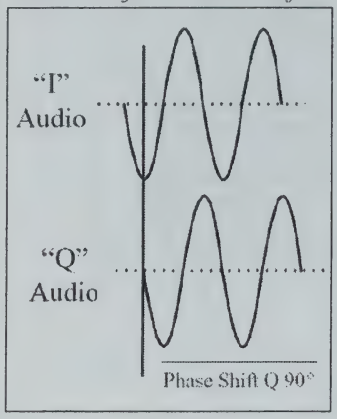
Amplify "As Is" to get a "Binaural" Receiver

Additional 90° Phase Delay Trick

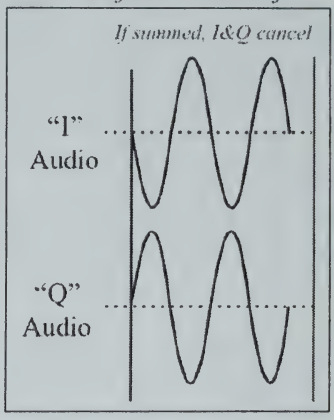
- Trick: Use Phase delay network to add an *additional 90° shift* between I and Q
- Now LSB I & Q are in phase
- While USB I & Q are 180° out of phase
  - *After phase shift, LSB signals add while USB signals cancel.*

Before and After - USB

USB – Before Phase Shift

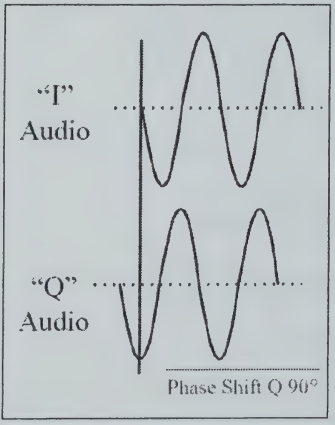


USB – After Phase Shift

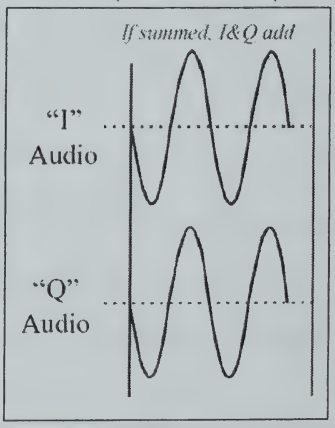


Before and After - LSB

LSB – Before Phase Shift



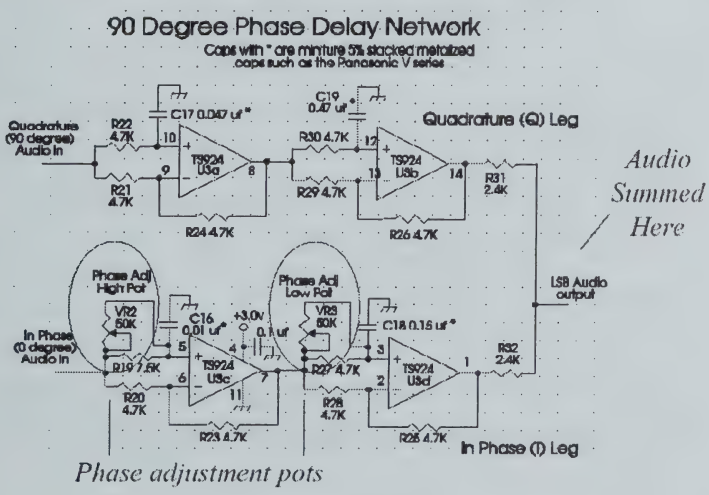
LSB – After Phase Shift



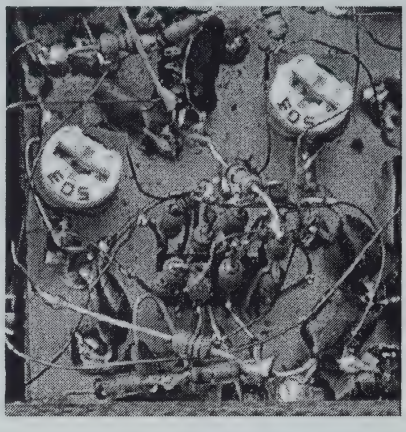
Norcal 30 Phasing Network

- When I/Q audio is applied to the phasing network, the USB sideband cancels out
- Component tolerances non-critical
- Opposite sideband rejection > 45 db
- Sideband rejection set using 3 trim pots
  - Balance / Low frequency / High frequency
- **Several passes through all three trimmers easily sets opposite sideband rejection**

Norcal 30 Phasing Network



HB Phasing Strip



Why use a 3v Receiver?

- Goal is to deliver audio signal to the ear.
- Normal headphone listening level is only 100 to 200 mV pk-pk.
- Small, efficient headphones typically rated ~ 40 mW max at 16 ohms.
- 40 mW / 16 ohms is 3.2v pk-pk
  - *But who wants to smoke their headphones?*
- 3v is more than enough for headphones.
- **12v wastes over 9v of battery energy!**

Why Use a Switching Supply?

To waste less power when using 12v!

Rough Guidelines

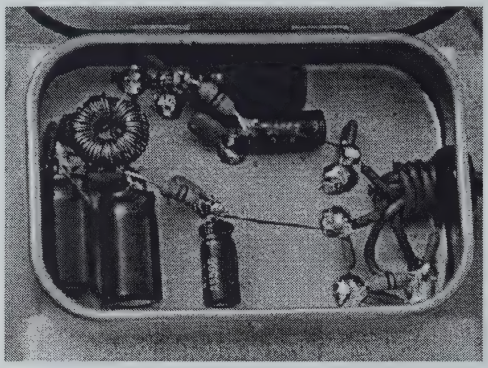
(3 ma at 3v) = (1 ma at 12v)

(2 ma at 5v) = (1 ma at 12v)

Switching Supply Savings:
32 ma vs. 13 ma

- Total: 25 ma, 3v and 7 ma, 5v; ~110 mW
- Linear LDO Regulators provide clean 3v, 5v
  - With 3.3v/5.5v in, LDO regulators burn 10%, 11 mW
- Switching Supply output: 3.3v, 5.5v
  - Switcher circuit is about 75% efficient at 12v
- Switcher: 161 mW in, 121 mW out
- Switcher input, ~13.4 ma at 12v
- **If no switching supply: 32 ma**
- ***Switcher saved ~19 ma at 12v.***

HB QRP Switching Supply



Altoids mini-tin magnetic shielding

Summary: Norcal 30 Design

- High performance Quadrature DC Detector
  - *Unmatched Overall Receiver Performance*
  - *High Rcvr Sensitivity/Excellent large signal performance*
- Single sided reception with phasing receiver
  - *> 45 db of USB suppression*
- Low power receiver
  - *3v, 110 mW*
- Switching supply minimizes current drain
  - *Only 13.5 ma at 12v*

QRP Operating

By Richard Fisher, KI6SN
1940 Wetherly Way
Riverside, CA 92506
KI6SN@yahoo.com

QRP ambitions on the Very High Frequencies

Alan Kaul, W6RCL, writes from La Canada, CA, that in the ARRL June VHF Contest he "operated a total of 5-hours QRP from DM04 (12-miles northeast of Los Angeles City Hall) and - while not burning up the band - enjoyed the contest.

"I had one opening on 6 meters into British Columbia, Washington and Oregon, and a couple of hours later another opening into Idaho on 6 meters.

"I heard no East-West signals at all."

Overall, Alan had 42 QSOs on 6 meters and 6 multipliers; 18 QSOs on 2 meters with 5 multipliers and 5 QSOs on 432 MHz in 4 multipliers for a total of 65 contacts in 25 multipliers and 1,750 points.

"My QSO No. 31 on 6 meters with W7QH in CN84, was 2 x QRP. He was also running 5 watts, but I don't know what the rig was.

If I remember correctly, he said he was also running a three-element Yagi.

"There may have been other QRP stations in the list of those worked, but I didn't make a big deal out of telling anybody, and neither did the other stations I worked.

"I did not identify as QRP except 2-3 times. The station was an FT-817, 3 element 6 meter Yagi at about 45-feet with a 175 foot coax run; 4 element Yagi on 2 meters at 15 feet (30 feet of coax, temporarily mounted on my front porch), and 10 element Yagi on 432 at 12 feet - below the 2 meter

Yagi on same mast, also with 30 feet of coax.

"The long coax run is a potential killer. On HF it is not a problem, but if I put the Yagis for 2 meters and 432 MHz on the crankup, I fear the signal loss through the extra length of coax would outweigh any potential gain by being 30-feet higher.

"If you had any QSOs during the VHF QSO Party, I urge you to send in your logs and to suggest (SOAPBOX - with your entry) that the sponsoring ARRL create a pure 5-watt QRP category in next year's contests.

"When 6 meters is open, distances of a thousand miles a watt are easily possible. Six wasn't that open (during the June VHF Contest weekend), and so the best I was able to do was about 200 miles per watt.

"Nonetheless, 1,000 miles on 5 watts is still respectable."

QRP at the campsite on Pyramid Lake

"Well, it wasn't exactly the best weekend as portable operations go," writes **Trevor Jacobs, KG6CYN,** of Burbank, CA.

"We arrived at a campsite at Pyramid Lake (near Los Angeles) around 10 p.m., so setting up the station on the first night was out of the question, as we had the tent to put up and people to chat with that we hadn't seen in a while.

"I got up Saturday morning, and as everyone was heading to the lake, I figured that I'd get a few hours of radio time in.

"By the time I'd had breakfast, cleaned up, got the station set up (FT-817 and MP-1) and was ready to operate, it was close to 10 o'clock.

"I listened around on 10 meters thinking that here may be an opening, but nothing was heard. Fifteen was the same. This brings us to around noon.

"I decided to move down to 20 meters and see if I

could hear any activity here. Didn't hear anything around 14.060, so I called CQ a few times with no takers.

"Then I moved up to the SSB portion of the band and heard a few strong stations chatting, so it appeared that the band was open.

"A few minutes later I heard Scott, N0OBA calling CQ from Aurora, CO. He was having a hard time receiving me, so we cut it short. At least I knew the rig was working, though.

"I decided to call CQ a few times and Bob W2NGK/5 from Albuquerque, NM came back and mentioned that he had monitored my last QSO with Scott and that I was a solid 56 out his way and 100 percent readable, so I started to feel a little better.

"Right about that time, I decided to go back down to 14.060 and try to round up at least one CW QSO while the band was open.

"I heard quite a bit of activity and decided to listen for a signing station to pounce on.

"This approach seems to work the best for me - or answering a CQ. As I was listening to a very strong station, it sounded as though someone had just pulled the antenna down.

"All of a sudden, the band went completely dead - no CW, no digital, no SSB, nothing.

"I checked WWV at 10 MHz, and there was nothing. I checked all of the bands and heard nothing. I knew that one of two things had just happened, and both would mean potentially no more radio for the day.

"Either A) the receiver in my FT-817 had just (bit the dust), or we had some kind of major solar event. Well, I gave my friend Dave, WD4PLI, a call on the phone and had him fire up his rig.

"To both of our surprise, the bands were indeed completely dead, deader than I've ever heard them. Well, at this point, since the truck was in the shade and all the kids were

at the lake (quiet!), I decided to take a little nap and try again later.

"About an hour or so later the group from the lake showed up so we hung out for a bit and ate some lunch. During lunch, the wind really picked up, and before I could get to the MP-1 antenna that was set up on the top of my Blazer, the wind blew it off the truck and snapped off the top section of the whip!

"Well, I wasn't too happy about that, but I took some Gaf tape and taped the section back on and also did a better job of securing the tripod.

"Sure could have used a couple of small sand bags to secure the tripod, but I made do with what was available.

"After we finished eating, I re-tuned the antenna and listened around a bit to see if 20 meters had come back to life. Well, I heard no CW at all.

"But I did hear one station in Georgia, as the GA QSO Party was going on that weekend.

"Anyway, I gave W4CEB a shout and he came back with a 57 report. And that was all she wrote.

"After that QSO I ended up spending some time with our friends and drinking a few chilled 807s.

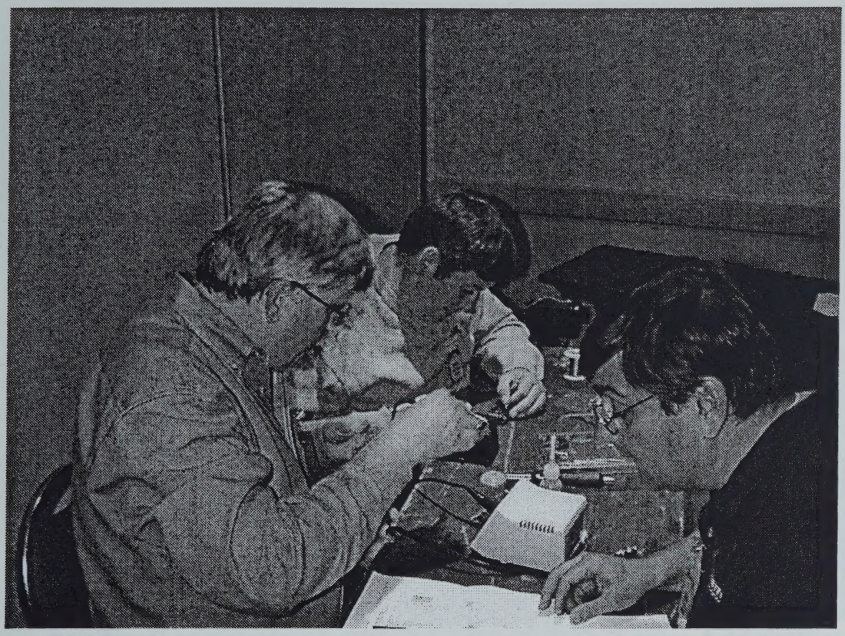
"The weather was typical for camping in this area - hot in the day and chilly at night.

"All in all, it was still a fun trip, even though the radio end of it didn't go quite as planned.

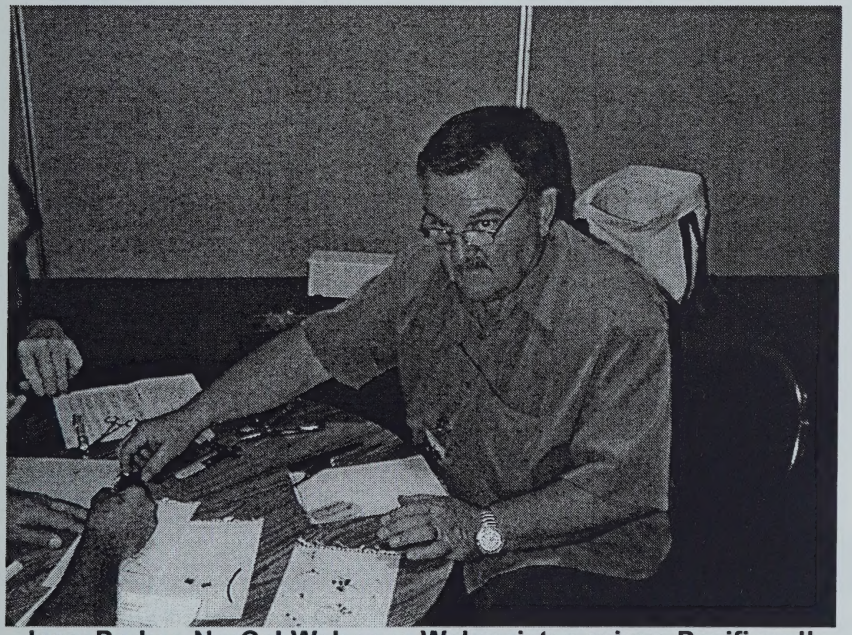
"The DSW never saw the light of day! I did realize on this trip that I need to come up with some better strategy for portable antennas.

"The MP-1 is a great little antenna for 20 and above. Heck, I've worked Japan on 10 meters with it at 2 watts!

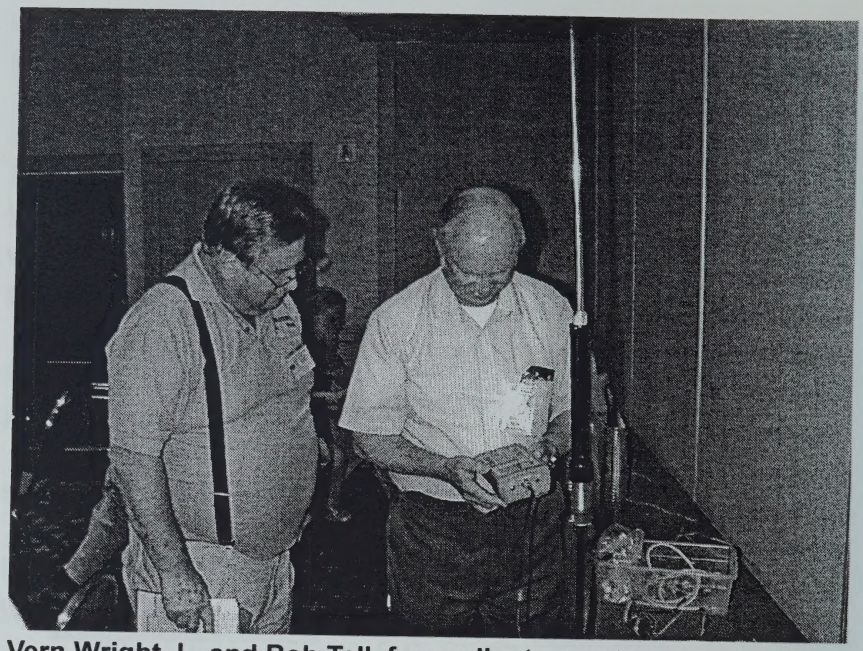
"But I'd like something for 30, 40, and 80 meters as well that would be more efficient. The wire antennas generally do great also, but a lot of times - especially on the beach - there are no places to hang them."



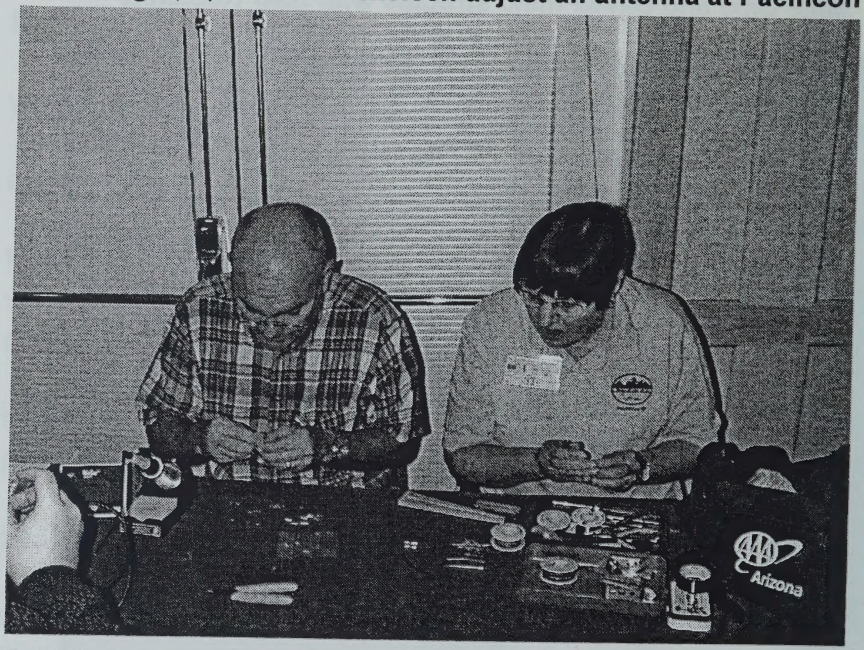
Mike Gipe and Dave Fifield struggle with their Rockmite



Jerry Parker, NorCal Webpage Webmeister enjoys Pacificon!!



Vern Wright, L, and Bob Tellefsen adjust an antenna at Pacificon



Rod Cerkony and Jan Medley build Rockmites during Pacificon Building Contest.

The NorCal Web Page

NorCal maintains a web page that has many late breaking announcements of interest to QRPers. Our web master is Jerry Parker, WA6OWR. Please check the web page at:

www.norcalqrp.com

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Paul Maciel, AK1P maintains the NorCal Database. If you have a question concerning your subscription please contact Paul at: ak1p@earthlink.net or by mail at:

PAUL A MACIEL
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